

**IMPACT ASSESSMENT DISCUSSION PAPER NO. 17**

**EVALUATING THE IMPACT OF  
AGRICULTURAL PROJECTION  
MODELING USING THE  
“IMPACT” FRAMEWORK**

**James G. Ryan**

**Director General's Office**

**International Food Policy Research Institute**

**2033 K Street, N.W.**

**Washington, D.C. 20006-1002**

**Tel: (202) 862-5600**

**Fax: (202) 467-4439**

**Email: [IFPRI@cgiar.org](mailto:IFPRI@cgiar.org)**

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## ABSTRACT

This paper attempts to assess the worth of the research that has gone into the IMPACT (International Model for Policy Analyses of Agricultural Commodities and Trade) framework at the International Food Policy Research Institute (IFPRI). It is the ninth in a series of studies commissioned by IFPRI to evaluate the impact of its research and related activities. It is part of a process aimed at improving the effectiveness of IFPRI's work and documenting for donors the wisdom of investing in it.

This paper describes the IMPACT framework and the major issues it has been used to address, as contained in the 108 documents that have been published, 55 percent in refereed external books or journals. The total output rate of more than 13 publications per year is extremely impressive by any standards, as is the refereed rate of 7.4.

There are many tangible indicators of the outcomes and influence of the IMPACT research and publications. The analysis showed that external peer-reviewed outputs of IMPACT are cited two to three times more frequently than the average economic articles in the professional literature. However, the citation rate is far below the most cited IFPRI publications and even well below the average of all IFPRI publications. IMPACT documents published by IFPRI are in heavy demand. The top three IFPRI IMPACT publications were consistently in the top ranks in requests for hard copies and in web downloads of IFPRI publications. Web downloads are more than 70 percent higher than hard copy requests for IMPACT publications. The most popular requests are those addressing global food projections, whether from hard copy requests or from web downloads. Publications addressing specific regions/commodities are in less demand.

There has been extensive national and international media coverage of IMPACT results, mostly in association with 2020 Vision conferences and other events. Numerous briefings at the highest levels have occurred. Clear evidence of the value of IMPACT outputs is the extent of derived demands for additional analyses and information that has come from users, as well as the myriad number of invitations to present invited papers at conferences. Others have also translated key documents, which illustrates their inherent value. Surprisingly, there have been few requests for copies of IFPRI's French and Spanish translations of a few documents. As a result, large stocks are still available. There have been an increasing number of requests to make the IMPACT model more transparent and accessible. IFPRI is responding to this.

In a survey of the international agricultural research and development (R&D) community, the vast majority of the 18 percent of respondents had read one or more IMPACT publications. Two-thirds of respondents found they contained new or surprising information or insights, and they listed 14 examples. One respondent, who was responsible for developing an alternative model, complimented the IMPACT framework for its rigor, comprehensiveness, and flexibility, which he contrasted to others. Its strength was also in the continued refinements and updating of databases. Among respondents, the IFPRI publications were much more popular than refereed

journal papers. Hence there would seem to be a trade-off in impact between the professional interests of the IFPRI researchers involved and the interest of the institution.

Respondents generally indicated that IMPACT publications were used more in research than in policy formulation. There was minor use in teaching courses such as in political science and development economics. International centers used the material extensively in strategic planning and priority assessment and in their publications. Donors and international organizations used them for advocacy and for briefing notes for ministers and other policymakers. IMPACT publications were cited nine times in peer-refereed publications of respondents. The projections of the Food and Agriculture Organization (FAO) and the World Bank (WB) were most frequently cited as alternatives also used by respondents.

The publications on the livestock revolution and China arguably have had the most discernible impact. The former has helped to elevate the priority accorded to livestock among the international community, especially the way in which smallholder livestock R&D strategies are conceptualized. This is being matched by investments in new initiatives by the Consultative Group on International Agricultural Research (CGIAR) and the WB, for example. The China Agricultural Policy Simulation (CAPSim) and IMPACT publications on future scenarios for China provided timely and valued alternative policy options to food self-sufficiency, which the government had embarked on in response to concerns about China's ability to feed itself in the longer term. The options concerning market liberalization and investments in agricultural research and development in China were given rigorous consideration at the highest levels, and policies were modified accordingly. The likely economic benefits of these changes are high, and can be ascribed in part to the insights derived from CAPSim and IMPACT. A conservative estimate of the benefit-cost ratio of CAPSim/IMPACT research on China that led to greatly increased agricultural R&D investments is 69, with an internal rate of return of 40 percent.

The overall conclusion is that the IMPACT framework represents a valuable international public good, which has been and continues to be refined and expanded to address emergent food policy issues. The number of alternative frameworks to IMPACT has declined in recent years and now numbers only three. IMPACT has unique features that are acknowledged by peers. If it is made more accessible and continues to be refined and relevant, it should remain a wise investment for IFPRI and the international community.

## **ACKNOWLEDGMENTS**

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## Acronyms

AAEA	American Agricultural Economics Association
ADB	Asian Development Bank
CAPSIM	China Agricultural Policy Simulation
CAS	Chinese Academy of Sciences
CAST	U.S. Council on Agricultural Science and Technology
CCAP	Center for Chinese Agricultural Policy
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centre International de Agricultura Tropicale
CIP	International Potato Center
DFAT	Department of Foreign Affairs and Trade
ERS/USDA	Economic Research Service, U.S. Department of Agriculture
FAO	Food and Agriculture Organization
FAPRI	Food and Agricultural Policy Research Institute
GAMS	General Algebraic Modeling System
GTAP	Global Trade and Agricultural Policy
IAE	Institute of Agricultural Economics
IARC	International Agricultural Research Center
ICLARM	International Center for Living Aquatic Resources Management
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
IFPSIM	International Food Policy Simulation
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
IMF	International Monetary Fund
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
IPGRI	International Plant Genetic Resources Institute
IRRI	International Rice Research Institute
ISI	Institute of Scientific Information
IWMI	International Water Management Institute
NARS	National Agricultural Research Systems
NGO	Nongovernmental Organization
SCI	Science Citations Index
SSCI	Social Science Citations Index
SWOPSIM	Static World Policy Simulation
TAC	Technical Advisory Committee
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WB	World Bank
WTO	World Trade Organization

# 1. INTRODUCTION

The International Food Policy Research Institute (IFPRI) has been engaged in food demand and supply projections since its inception in 1975. The early work was primarily focused on assembling historical data from which trends were extrapolated under varying assumptions about future influences on them. Expert opinion was used for this. In the early 1990s, IFPRI developed a global partial equilibrium trade model to base its projections on a stronger behavioral foundation. This enabled various policy scenarios to be explicitly modeled to assess their consequences on food prices, productivity, production, demand, trade, and food and nutrition security. This model was referred to as the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT).

IMPACT was a crucial component of the IFPRI 2020 Vision for Food, Agriculture, and the Environment to develop a shared vision and consensus for action on how to meet future world food needs while reducing poverty and protecting the environment. Many of the outputs of the research using the IMPACT framework have been published and communicated under the auspices of the 2020 initiative, as described by Paarlberg (1999). There have also been papers in the professional literature.

This paper attempts to assess the worth of the research that has gone into the IMPACT framework. It is the ninth in a series of studies commissioned by IFPRI to evaluate the impact of its research and related activities. It is part of a process aimed at improving the effectiveness of IFPRI's work and documenting for donors the wisdom of investing in it.

The paper will first describe the IMPACT framework, including the model and the 10 major issues it has been employed to address. This is followed by documentation of various tangible indicators of the outcomes derived from the various outputs and their influence on researchers and policymakers. This includes the extent of citations of IMPACT publications in the literature, demand for copies of the publications, media response, and derived demands for additional research. A discussion of users' perceptions of the IMPACT information's value and impact to users and their institutions follows. This is based upon a mail survey. A concluding section follows.



## 2. THE IMPACT FRAMEWORK AND ITS OUTPUTS

The development of the basic IMPACT model at IFPRI began in earnest in 1995. In this section, we will describe the antecedents and evolution of the model, the major applications on which it has been used, and the publication and other outputs that have resulted.

### Model Evolution

The precursor to the IMPACT model was developed in 1993 under a joint project between IFPRI and the International Rice Research Institute (IRRI) that examined the demand and supply prospects for rice in Asia. It was referred to as the International Food Policy Simulation (IFPSIM) model, and Dr. Oga from Japan was its primary architect (Oga and Gehlar 1993). IFPSIM used General Algebraic Modeling System (GAMS) and was first discussed at a conference in Beijing in 1995. Rosegrant, Agcaoili-Sombilla, and Perez (1995) then built upon IFPSIM to develop the first IMPACT model. It was a primary ingredient in the IFPRI 2020 Vision initiative and continues to be acknowledged as such several years on (Paarlberg 1999).

IMPACT consisted of 35 country or regional partial equilibrium equations that determine demand, supply, and prices for 17 agricultural commodities.<sup>1</sup> The equation structure was linear in logs and was derived from the family of equations in the Static World Policy Simulation (SWOPSIM) model developed in the United States Department of Agriculture (USDA) (Roningen, Sullivan, and Dixit 1991). Growth in crop area and yields per hectare for each crop and country are determined by crop and input prices and by nonprice factors such as the rate of technological change, which is in turn a function of research, irrigation, and other investments. Demand is the sum of demand for food, feed, and other uses and is a function of own prices, prices of substitute commodities, income, and population growth. The values of the latter two variables were based upon assumptions. There is no demand relation for commodity stocks. Consumption and production are equilibrated through recursive nonspatial world commodity trade flows, with world commodity prices determined endogenously. The net trade position of each country is shown, but without specifying import sources or export destinations. The model also projects the numbers of malnourished preschool children in developing countries based upon derived and trend relations between this statistic and per capita calorie availability, growth in social expenditure, female education, and access to clean water.

The model allows a price wedge between domestic and world prices using consumer and producer subsidy equivalents and allows for distortions like acreage restrictions in the United States. World prices thus influence domestic prices, but the relationships are mediated by these various distortions. There are linkages between agricultural and nonagricultural sector growth. Price and income elasticities were estimated and synthesized specifically for the IMPACT model from various sources.

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<sup>1</sup> The initial 1995 model disaggregated rice into indica and japonica. These were merged in the 1996 version due to a lack of interest by users and the lack of precise data on the two types.

The original 1995 IMPACT model has been refined to address emergent policy issues. In 1996, roots and tubers were disaggregated into potatoes, sweet potatoes and yams, cassava, and other roots and tubers (Scott, Rosegrant, and Ringler 2000a and 2000b). This was initially stimulated by the International Potato Center (CIP) for potatoes and sweet potatoes. It was then expanded to include yams and cassava, involving the International Institute of Tropical Agriculture (IITA), the Centre International de Agricultura Tropicale (CIAT), and the International Plant Genetic Resources Institute (IPGRI). An additional impetus was the CGIAR Inter-Center Review of Roots and Tubers.

Modifications were also made to the demand and supply equations (Rosegrant et al. 1997). In the case of supply, irrigation was included in the area response function via increases in crop intensity. The yield function was differentiated into irrigated and rainfed responses. At the same time, nonprice variables were rationalized such that they primarily reflected only the impact of investments in research and extension. Demand functions were modified to provide a dynamic adjustment of income elasticities related to income. Price elasticities were also revised. These adjustments were primarily to accommodate the effects of increasing urbanization and income growth. The base data also were updated from 1990 to 1993 and the 1996 United Nations population projections incorporated. Agricultural research investment data also were updated.

In 1999, the former Soviet Union was disaggregated into two regions, Central Asia and the rest. More recent versions of IMPACT include: (1) the effects of private sector research and development, education, and roads on commodity production growth; (2) livestock product yields and the effects of animal feed conversion ratios on them; (3) the effects of differences in the quality of maternal and child care on the incidence of child malnourishment; and (4) an IMPACT-WATER module to enable increasing competition for water between the agricultural and nonagricultural sectors to be more explicitly addressed by adding a water simulation model to the commodity supply functions. These refinements are discussed in detail in Rosegrant et al. (2001a, pp. 49–57), Rosegrant and Ringler (1999, 2000b), Rosegrant and Cai (2000 and forthcoming), and Cai and Rosegrant (forthcoming), along with the further updates to the databases and elasticity assumptions. In work currently underway, the commodity coverage is being expanded to number 31 and will include temperate, tropical, and semi-tropical fruits; vegetables; sugar and sweeteners; 8 fish commodities; and fishmeal. The full equation system for IMPACT was posted on the IFPRI website in early 2002. All the elasticities will be posted when the fish parameters have been developed, which is expected by the end of 2002.

## **Model Applications**

There have been a total of 108 publications related to the IMPACT model (Table 1). These are listed in Appendix 1.<sup>2</sup> Some 55 percent of these have been in external professional refereed publications. This indicates that the framework and its many applications have been subjected to considerable peer review. The frequency of

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<sup>2</sup> In addition to these formal publications, numerous presentations have been made to wide-ranging audiences, as discussed later in the paper.

publications of all types at more than 13 per year is very high. Even the refereed rate of 7.4 per year is extremely high by most standards.

**Table 1. Number of IMPACT publications 1995–2002**

Type of publication	Number
Books, monographs, book chapters	31
Papers in refereed journals	29
Papers in discussion/working paper series	9
Papers presented at workshops and conferences	25
Policy briefs, special reports, and other	14
Total	108

Source: Compiled by the author

The IMPACT framework has been used to address 10 major issues. These are, in broad chronological order:

1. Global food demand and supply projections
2. Root and tuber projections
3. Future projections for China
4. Future projections for South Asia and Sub-Saharan Africa
5. The effects of the Asian economic crisis
6. Dietary patterns and nutrition
7. Effects of growing water constraints on food security
8. Livestock products demand and supply projections
9. Asian projections
10. Economic consequences of crop genetic improvement

A brief synthesis of the results and conclusions from these applications follows. This will provide necessary background to later analysis of indicators of the outcomes, impact, and value of the framework and its applications, and of users' perceptions of their influence.

### Global Food Projections

Arguably this has been the most public face of the IMPACT framework. Four major global assessments have been undertaken. The first was in 1995 at the inaugural 2020 Vision Conference in Washington, D.C. (Rosegrant, Agcaoili-Sombilla, and Perez 1995). It concluded, using baseline data and assumptions, that world food prices would continue to decline to 2020, yet food security for hundreds of millions would not improve. In Sub-Saharan Africa, it would actually decrease. Articulating the apparent paradox of regional food and nutrition insecurity amid global food plenty has been a feature of outputs from the IMPACT framework.<sup>3</sup> The annual rate of growth in animal product demand in developing countries (3.2 percent) was projected to far exceed that of cereals (2.0 percent).

<sup>3</sup> McCalla and Reverodo (2001) conclude that for many of the projection models, including the IMPACT framework, their global estimates have come close to the actual data in an *ex post facto* validation analysis. However, large errors have occurred in the regional and country projections.

Four variants to the baseline analysis were examined: (1) lower population growth; (2) lower investments in national and international agricultural research, health, education, and sanitation with reduced nonagricultural income growth; (3) higher investments in research; and (4) trade liberalization. In examining the effects of reduced public investment in agricultural research, the conclusion was that food prices would stop declining and the bleak nutritional picture would become even worse.

Revisions and updates to the basic model as described in Rosegrant et al. (1997) were used in the second major global assessment (Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1997).<sup>4</sup> The analysis highlighted the increasing child malnutrition problem in Sub-Saharan Africa, the only region where the numbers of malnourished children are expected to increase by 2020. The food gap in developing countries was expected to double in the same period, leading to increased food imports. The report addressed a number of emergent issues likely to affect food security of developing countries. These included rising cereal prices and falling food stocks, effects of changes in lifestyles and incomes in China and India on global food security, influence of Eastern Europe and the former Soviet Union, the special needs of Sub-Saharan Africa, climate change, growing water scarcities, declining soil fertility, and trade liberalization. It stressed the need for continued investments in agricultural research and improved policies if poverty and food insecurity are to be reduced.

### **Box 1. Comparisons with Other Projection Models**

The IMPACT model is one of seven examples of world nonspatial trade models cited by McCalla and Revoredo (2001) in their recent critical appraisal. This family of models contrasts with three others: pure trend projection models (four examples), extended trend projection models (one), and world spatial trade models (two). They note that the number of institutions engaged in agricultural commodity projections has decreased in recent years. The current four major players are FAO, Food and Agriculture Policy Research Institute (FAPRI), IFPRI, and USDA. The number of projection modelers seems to fluctuate with the periodic rises in world food prices or falls in global stocks.

In terms of *ex post facto* cereal production projections to 2000, comparisons among five models by McCalla and Revoredo (2001, p. 24) showed the USDA model was the most accurate in five of the ten regional situations examined, the IMPACT model three times, and IFPSIM was equal with USDA once. The WB and FAO models were not the best predictors in any case. The models generally did much better at predicting actual production at the global than at regional and country levels and for food aggregates than individual commodities. Generally, the smaller the country or region, the worse the projection. Data problems were seen as a major cause of error, especially in developing countries. For developed countries, modeling complicated domestic policies, including quantitative border restrictions, seems to be the major issue.

Many models are used for regional, country, or commodity policy analyses, so the greater projection inaccuracies at these disaggregated levels are of concern. As McCalla and Revoredo (2001) point out, since most are normative, not positive, models, validation by comparing actual with projected outcomes is inappropriate. "A more appropriate test may be whether or not the analysis enriched the policy debate. In fact, 'failure to come true' could be considered by the authors to be a sign of success because an undesirable outcome was avoided" (p. 42). This is the approach taken in this evaluation.

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<sup>4</sup> Although the global assessments in Pinstrup-Andersen, Pandya-Lorch, and Rosegrant (1997 and 1999) drew significantly on the IMPACT framework and projections, they also drew heavily on FAO and other non-IFPRI sources. They also focused on current issues for CGIAR using both IMPACT and other IFPRI research.

The third global assessment was published in Pinstrip-Andersen, Pandya-Lorch and Rosegrant 1999. The report highlighted the dominance of developing countries in future food demand growth to 2020 and the emergence of a demand-driven livestock revolution in these countries. This will place upward pressure on feedgrain demand, which will overtake demand for rice and wheat by 2020. Crop yield increases will have to provide 80 percent of the required increase in global cereal production. This may be difficult in view of the recent slowing of growth in farmers' yields. Net cereal imports by developing countries were projected to double by 2020 and net meat imports to increase eightfold. Most imports will come from developed countries. These factors will mean food prices will remain steady or fall slightly, which is in contrast with earlier projections. Global child malnutrition is projected to fall by 15 percent to 2020. But Sub-Saharan Africa and South Asia will remain "hot spots" of child malnutrition and food insecurity. The report discusses six critical issues that could influence the world food situation: policies that could improve child malnutrition, continued declines in world food prices, the importance of active participation of developing countries in the World Trade Organization (WTO) negotiations, the roles of agroecological approaches in modern biotechnology, new information technology, and precision farming in enhancing productivity of smallholders.

The most recent global assessment (Rosegrant et al. 2001a and 2001b) was timed to coincide with the IFPRI 2020 Vision Conference on "Sustainable Food Security for All by 2020," held in Bonn, Germany, in September 2001. The IMPACT model used incorporated all the refinements mentioned earlier, except for the IMPACT-WATER module. The base data were updated to 1997. A number of scenarios were explored using IMPACT: (1) lower population growth rates; (2) low and high yield growth rates for both crops and livestock; (3) full trade liberalization; and (4) optimistic and pessimistic assumptions about income growth; investments in sanitation, health, and education; agricultural technology; environmental degradation of agricultural land and water; and expansion of agricultural land and irrigation. The effects of these on demand, production, prices, malnutrition, and trade were assessed.

Changes in yield growth assumptions had major effects on prices. Trade liberalization would increase prices, especially of rice and meats. The paradox of slowly declining food prices and buoyant international trade coexisting with continuing child malnutrition, especially in Sub-Saharan Africa and South Asia, was again reinforced in these analyses. The required public investments to reverse these trends as derived from the model are presented. China is projected to be the major importer of food in 2020, with its import bill increasing threefold. However, even if India and China become major cereal importers due to disappointing yield growth and degradation, the rest of the world should be able to supply these needs without major dislocation.

### ***Root and Tuber Projections***

The disaggregation of roots and tubers into cassava, potato, sweet potato, and yams was combined with other refinements to the IMPACT model completed in October 1998 and outlined earlier, to assess future scenarios for these species (Scott,

Rosegrant, and Ringler 2000a and 2000b). The model also adjusted for declining income growth occasioned by the Asian economic crisis.

The baseline projections to 2020 show that roots and tubers will marginally decline in economic importance compared to food and feedgrains. Prices of sweet potato and yams will fall by some 23 percent, cassava by 15 percent, and potato by 14 percent. Projected demand growth is most rapid for potatoes. However, in a high demand and production growth scenario, the relative importance of roots and tubers will marginally rise and the price declines will be far less. The changes in the regional patterns of growth in the various species under the different scenarios were elaborated also. The conclusion was that roots and tubers have a heretofore-neglected role to play in generating cash income for the poor and in improving food security.

### ***Future Projections for China***

The price spikes for cereal grains in 1996 provided the background for an assessment, using the IMPACT framework, of the likelihood that this would be the start of a more permanent upward trend, as a result of China's growing demand for food grains and its inability to satisfy this demand from domestic production. Wheat and maize prices were 50 percent higher in 1996 than a year earlier and rice prices were 20 percent higher than in 1994. World cereal stocks at 13 percent of consumption were the lowest in history. Brown's emotive book (1995) heightened concerns about world food security at that time. The IMPACT analyses focused on China were published in a number of forms (Rozelle, Huang, and Rosegrant 1996; Rozelle and Rosegrant 1997; Huang, Rozelle, and Rosegrant 1997 and 1999; Rosegrant, Paisner, and Ringler 2000b). In later work, Huang further refined the China model (Huang, Rozelle, and Rosegrant 1997 and 1999) into the CAPSim (China Agricultural Policy Simulation) model.

The CAPSim model, which incorporated simulation results on world price changes from the IMPACT model, was used to assess the effects of China's income growth, urbanization, and market development on food demand and the influence of technology, agricultural investment, environmental trends, and institutional innovations on China's food supply. Brown (1995) projected a 20 percent decrease in grain production between 1995 and 2030, primarily due to environmental degradation, urban encroachment on agricultural land and poor farm policies. The IMPACT framework projected that while China will still be a large net importer of grain, it will not demand so much as to swamp world grain markets in the manner Brown envisaged. IMPACT projections to 2020 of China's imports were less than 25 percent those of Brown in the most likely case and 60 percent in the less likely. World grain prices would in any event not rise to levels that would dislocate trade patterns.

Only on the most pessimistic assumptions about environmental degradation leading to an annual decline in land productivity of 8 percent or a dramatic decline in agricultural research investments did IMPACT project Brown's level of imports. "Doomsday scenarios for China and the world food situation are not plausible, because they ignore the interrelationships and responsiveness built into the world food economy" (Rozelle and Rosegrant 1997, p. 196). "...China...does not represent

a major threat to the long-term stability in these (world food) markets” (Rosegrant, Paisner, and Ringler 2000b, p. 10).

The framework developed in Huang, Rozelle, and Rosegrant (1997 and 1999) involved a more elaborate China model, which was linked to but independent of the IMPACT model and was used to assess China’s impact on world trade and prices. The China component had separate demand functions for the rural and urban sectors and allowed rural-urban migration and explicit inclusion of erosion and salinization in supply responses. As with the other studies cited earlier, Huang, Rozelle, and Rosegrant (1997 and 1999) concluded that Brown’s pessimism about the effects of environmental stress on China’s imports of grain was unfounded.

CAPSim is now used extensively to evaluate policy options in China in the Center for Chinese Agricultural Policy (CCAP) of the Chinese Academy of Sciences (CAS). It is currently being linked to computable general equilibrium models and the Global Trade and Agricultural Policy (GTAP) model from Purdue University and also will have a biophysical module.

### ***Future Projections for South Asia and Sub-Saharan Africa***

South Asia and Sub-Saharan Africa have received particular attention in applications of the IMPACT framework. Agcaoili-Sombilla and Rosegrant (1996) employ the IMPACT model to illustrate the effects of reduced investment in agricultural research, lower income growth, and reduced investment in social services on cereal imports and child malnutrition in South Asia. The results show that progress in reducing food insecurity would fall by 50 percent in such a scenario and child malnutrition would increase in South Asia. In the baseline scenario, once again, the global food situation exhibits a balance in demand and supply, with food prices declining but with the paradox of little improvement in food security in South Asia, and a worsening in Sub-Saharan Africa.

Kumar and Rosegrant (1997) incorporated refined estimates of elasticities of supply to modify the IMPACT model and examined the food projections for India for cereals to 2000, 2005, 2010, and 2020. The overall cereal supply projection for India was less than 1 percent more than that estimated in Rosegrant, Agcaoili-Sombilla, and Perez (1995). However, the individual crop projections were vastly different. The Kumar and Rosegrant projections for rice were 8 percent greater than in Rosegrant et al., coarse grains 34 percent greater, and wheat 24 percent less.

More recently Rosegrant, Paisner, and Ringler (2000b) examined the implications of a pessimistic scenario of a decline of 50 percent in the growth rates of crop areas and yields in China and India compared to the baseline assumptions in the IMPACT framework. In this instance, India would be a net cereal importer in 2020 as cereal production declines 10 percent from the baseline. Per capita food availability would decline in both countries. Food prices would rise from baseline values, but not to devastating levels. The pessimistic scenario for Sub-Saharan Africa entails a doubling of its food imports compared with the baseline to 2020. Child malnutrition would rise from 31 million in 1995 to 44 million in 2020, some 4 million more than in the baseline. Increased investments in yield-enhancing interventions, increased

female education, female/male life expectancies, and clean water are projected to lead to large reductions in child malnutrition in Sub-Saharan Africa.

It is notable that some IMPACT projections of meat consumption in India were considerably lower than others from IFPRI had projected (Bhalla, Hazell, and Kerr 1999). Such differences are perhaps not surprising in what is predominantly a vegetarian society undergoing significant economic growth and changes in consumer preferences. This illustrates that IFPRI is prepared to publish sometimes-conflicting policy conclusions when there are genuine grounds for disagreement. This is to be applauded.

### ***The Asian Economic Crisis***

The likely effects of the Asian economic crisis, which began in 1997, were assessed using the IMPACT framework (Rosegrant and Ringler 2000a). The scenarios reflected currency devaluations and their duration and reduced economic growth. In the severe scenario, the model projected a decline of 3 percent in global cereal demand and 0.8 percent in the modest scenario. Global feed grain demand would decline much more at 6.4 and 1.8 percent, respectively. Global meat demand would decline to an even greater extent (8 and 2 percent), driven largely by China's reduction in demand. Global cereal production was projected to decline much less than demand as a result of currency-induced increases in domestic prices in Asia despite falling international prices. However, global meat production would decline by more than demand falls. Global cereal and meat trade would fall, especially in Asia. Daily per capita calorie availability would decline in developing countries. In the severe case, child malnutrition would rise by 15 million; in the modest scenario, the rise is 3 million.

### ***Dietary Patterns and Nutrition***

Rosegrant, Leach, and Gerpacio (1999) examined the effects of changes in the meat consumption preferences of consumers in developed countries on food and nutrition security. The hypothesis was that the effects of reduced derived demand for cereals occasioned by a reduction in demand growth for meats would translate into lower food prices and improved food and nutrition security in developing countries. The background for the scenario analyses in this paper was a dramatic reduction in the growth rates of per capita cereal food use in both developing and developed countries in the past 30 years, declining cereal prices, and a continuing rapid growth in meat demand in developing countries but more modest growth in developed countries.

The IMPACT baseline projections showed that demand for meat in developing countries would grow at 2.9 percent per year to 2020, compared with a figure of 0.5 percent in developed countries. Food prices were projected to decline, but at a slower rate to 2020 than in the past decades. Meat prices were also projected to decline markedly. In this baseline run, child malnutrition was projected to fall from 185 million currently to 147 million in 2020.



Two scenarios reflecting reduced meat demand patterns in developed countries were assessed. The first reduced the income elasticity of demand for meat in those countries to  $-1$  from zero in the baseline; this resulted in a 50 percent reduction in per capita meat demand in 2020 compared to 1993. The second scenario combined the first plus an increase in cereal consumption in developed countries to keep energy consumption the same. Meat prices fall by 22–33 percent in the first scenario and by a little less in the second. Both scenarios result in reduced prices of coarse grains but not of rice and wheat.

In developing countries, the results were somewhat counterintuitive: per capita cereal consumption is higher. When combined with the increase of 13 percent in meat consumption in developing countries, it results in a decline in the numbers of malnourished children of 3.6 million or 2.5 percent in the first scenario and 1.5 million in the second (1 percent), compared to the baseline. In India, however, the number of malnourished children increases as reduced wheat consumption from the rise in wheat prices is not offset by increased meat consumption from reduced meat prices.

The main conclusion was that reducing meat consumption in developed countries is not an effective way to improve food security in developing countries.

### ***Growing Water Constraints***

The growing competition for water for industrial and domestic uses versus agriculture has led to use of the IMPACT framework to assess the impact on food security of a future decline in the rate of expansion of irrigation, and reductions in agricultural water use leading to reduced crop area and yield growth (Rosegrant and Ringler 1999 and 2000b). In many developing regions, there are limits to the further development of water resources to satisfy the growing demands, and transfers of water from agriculture are viewed as inevitable by the authors. The IMPACT framework projects reductions in agricultural water use in developing countries of from 10 to 35 percent under these scenarios. This would have major effects on global food markets, with rice production affected the most in terms of yield and production declines and price rises. Wheat and maize also would be adversely affected. Food imports by developing countries are projected to increase substantially.

The above two papers and related papers examine technology and policy options to mitigate the emerging water constraints (Rosegrant 1997). These include transferable and tradable water rights, water harvesting and recycling, hydropower, desalinization, recycling, demand management, participatory user systems, and conservation.

The recently developed IMPACT-WATER module elaborated in Rosegrant and Cai (2000 and forthcoming) and Cai and Rosegrant (forthcoming), specifies that water available for food production depends on precipitation, runoff, evapotranspiration, water supply infrastructure, and socioeconomic and environmental policies. Crop water demand and supply for irrigation are simulated, taking account of year-to-year hydrological fluctuations in river basins, irrigation development, growth of industry and domestic water uses, environmental and other

flow requirements, and water supply and use infrastructure. Crop area and yield are mutually dependent on evapotranspiration, as well as other determinants in the earlier IMPACT model. Water allocation among crops is based on yield sensitivity to water stress, crop value, and crop water demand. The baseline for the model recreates the global hydrology of 1961–91 and projects water consumption and use to 2021–25.<sup>5</sup>

Five simulations to 2021–25 are performed and compared to the baseline: (1) high nonirrigation water demand; (2) low investment in infrastructure; (3) a 10 percent improvement in effective rainfall in water-scarce countries; (4) as in (3) but also with low investment as in (2); and (5) a 15 percent improvement in effective rainfall in Sub-Saharan Africa. The first two scenarios result in large reductions in cereal production and consequent price rises as a result of reduced irrigation water consumption of more than 22 percent. Cereal imports in developing countries increase substantially. Real incomes of poor consumers fall and malnutrition rises. In scenario (3), cereal production increases by 5 percent and prices fall by 10 percent. In (4), the reduced investments negate the effects of the improvement in effective rainfall in (3). Scenario (5) leads to a reduction of 50 percent in cereal imports into Sub-Saharan Africa.

The model has also been used to assess the effects of withdrawal of water from agriculture in North America (Rosegrant, Runge, and Cai 2000). The conclusion was that there would be small effects on aggregate crop production at the margin but significant effects in basins where water is already scarce and there is a high dependence on irrigation. IMPACT-WATER can be used to examine the effects of climate change and drought on water availability and crop production but has not been to any significant extent as yet.

### ***Livestock Product Projections***

The IMPACT framework was employed extensively in the joint IFPRI/FAO/ILRI (International Livestock Research Institute) study, which examined the revolution in livestock demand and supply in developing countries (Delgado et al. 1999). The baseline showed that global livestock product consumption would grow to 2020 at about half the rate of the past 15 years. However, consumption growth in developing countries would far exceed that in developed countries. Production growth in the former would also far outstrip that in the latter. Feedgrain use would grow rapidly in developing countries but would be relatively stagnant in developed countries.

Various scenarios were modeled using the IMPACT framework and compared with the baseline. These included: (1) a prolonged decline in economic growth in Asia; (2) structural change in tastes in India toward increased consumption of milk and meat; (3) secular increase in feed conversion efficiency; and (4) secular decrease in feed conversion efficiency.

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<sup>5</sup> By smoothing over several years, the model avoids the randomness of choosing a single year, which is an advantage when dealing with the vagaries of weather events.

Under scenario (1), meat, milk, and feed consumption would fall relative to the baseline, especially in China and India. However, this would only reduce growth from 200–300 percent to 160–240 percent to 2020. Trade in feedgrains would be substantially reduced and livestock product trade patterns altered significantly. In scenario (2), the effects are the opposite of (1); namely a 34 percent increase in world milk consumption, 19 percent increase in beef and mutton, 4 percent in poultry, and 8 percent in feed use, compared to the baseline. The effects on Indian consumption are much more dramatic, with increases between 150 and 500 percent. This is accompanied by major increases in India's net imports of livestock products and feedgrains. The effects of changes in feed conversion efficiency in (3) and (4) on livestock product consumption are relatively modest, especially in developed countries. However, there are significant increases in feedgrain consumption as efficiency decreases and the opposite when efficiency increases. This impacts livestock product and feedgrain trade patterns.

The livestock revolution and the various scenarios modeled to 2020 are not projected to affect world prices of either livestock product or feedgrain prices to a major extent. World grain markets are shown to have sufficient capacity to handle the additional demand for feed. Indeed, the livestock revolution prevents cereal prices from falling further from their historically low levels and perhaps even increases them slightly, but to nowhere near their levels in the early 1980s.

### ***Asian Projections***

The recent strategic study on rural Asian futures commissioned by the Asian Development Bank (ADB) relied heavily on simulations using the IMPACT framework (Asian Development Bank 2000). Chapter IV of this publication on alternative futures to 2010 summarizes the three IMPACT scenario analyses.<sup>6</sup> The first was a baseline, the second a low investment/weak reform agenda, and the third a high investment/strong reform agenda.

The analyses array the effects of the three scenarios on basic food (cereals, roots, tubers, meat, and milk) prices, per capita food availability, and the numbers of malnourished children in Asian regions. They indicate that the third (optimistic) scenario would result in 55 million fewer malnourished children in 2010 than the second (pessimistic) one. This would require only a modest increase in the commitment of governments in the region. However, to eradicate child malnutrition by 2020 in Asia, the analyses indicate that Asian economies would have to grow at rates of 8–10 percent per annum, cereal yields by 1.45 percent per annum in East Asia, 1.9 percent in Southeast Asia, and 2.44 percent in South Asia. These are within the experience of these economies since the Green Revolution. To achieve these targets would require a 50 percent increase in social spending and significant increases in government investments in agriculture. These conclusions are reflected in the final chapter, which summarizes the conclusions and recommendations from the complete ADB study.

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<sup>6</sup> An unabridged version of this is in Chapter 12 of Rosegrant and Hazell (2000).

### ***Economic Consequences of Crop Genetic Improvement***

The IMPACT model has been used recently to gauge the economic effects of crop genetic improvement research undertaken by the National Agricultural Research Systems (NARS) and CGIAR centers since their inception (Evenson and Rosegrant forthcoming). Two counterfactual simulations were conducted examining the effects on food prices, production, consumption, and international food trade in 2000 if, (1) the developing countries were constrained to have had no crop genetic improvement research after 1965, while developed countries realized the level of crop genetic improvement they actually achieved, and (2) the International Agricultural Research Center (IARC) system had not been built but NARS gains from crop genetic improvement research in both developed and developing countries would have been realized.

The weighted prices for all crops would have been 35 to 66 percent higher than they were in 2000 if scenario (1) had eventuated. Global production would have been 8 to 12 percent lower. This would be made up of an increase in production of 5 to 7 percent in developed countries and a reduction of 16 to 19 percent in developing countries. In the less pessimistic scenario (2), where only the IARC programs were absent, prices would have been between 18 to 21 percent higher and global production between 4 and 5 percent lower, comprising 1 to 2 percent more production in developed countries and 7 to 8 percent less in developing countries.

The effects on child malnutrition are starker under the two scenarios. Under (1) there would have been 32 to 42 million more malnourished children, while under (2) there would have been 13 to 15 million more. In developing countries, under (1) per capita calorie availability for the whole population would have been 10 to 13 percent less and under (2) 4 to 5 percent less. Hence national and international crop genetic improvement research has generated substantial and measurable benefits to the poor in improved food and nutrition security.

### 3. TANGIBLE INDICATORS OF OUTCOMES AND INFLUENCE

In this section, we will describe various measures of the extent to which the outputs described in the previous section have led to use of the information or an effective demand for it. These are often described as the intermediate products that are the precursors of an influence on policy processes and policy changes. The intermediate products include citations in the professional literature, publication requests and downloads from the IFPRI website, and invitations to present papers and undertake analyses and translations.

#### Citations Analysis

A citation search was undertaken using the Institute of Scientific Information's (ISI) Science Citations Index (SCI) and the Social Science Citations Index (SSCI).<sup>7</sup> These databases include only papers in the peer-refereed journals covered by ISI. They do not capture books, book chapters, discussion and working papers, or other "gray literature." The latter outputs from the IMPACT program represented almost two-thirds of the total (Table 1 and Appendix 1). However, the extent of citations in the professional literature is an important indicator of both quality and importance. However, as Kilpatrick Jr. (1998) points out, not all heavily cited papers are automatically of high quality. Flawed papers that are rightfully discredited by others can be cited as often as are seminal papers of genuine intellectual influence. Hence citation analysis is at best only a partial guide to impact and should be complemented by other measures.

The key seven refereed journal papers using the IMPACT framework that appeared in the SCI/SSCI search had an average of 2.43 total citations each up to March 2002. The range was from 0 to 5 (Table 2). This amounted to an average of about 1 citation per paper per year since publication. This compared with an average of 2.38 citations per paper per year for the most cited articles at IFPRI from 1992 to 1996, with a range of from 4 to 17 in total citations.<sup>8</sup> Hence the IMPACT refereed journal papers have 42 percent of the average citations of the most cited IFPRI papers. Looking at all IFPRI cited papers in the SCI/SSCI databases, the simple average from 1992 to 1996 is 1.50 per paper per year.<sup>9</sup> The IMPACT papers are cited on average two-thirds of the time of the average IFPRI paper. One reason for this may be that the outputs from the IMPACT framework appear more frequently in "gray literature" years before the appearance of journal articles than other IFPRI work

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<sup>7</sup> I am grateful to Luz Marina Alvare and her colleagues in the Library at IFPRI for their assistance in these searches.

<sup>8</sup> Derived by the author from Pardey and Christian (2002, Appendix Table 1, pp. 57–62). These data are comparable to those in Table 2 as both cover a five-year period and involved citation counts up to just over one year after the last year of the respective period examined.

<sup>9</sup> Derived by the author from Pardey and Christian (2002, Figure 7, p. 43).

does.<sup>10</sup> Appendix 1 provides a complete list of IMPACT publications, “gray” and other.

The norms of Glänzel cited by Pardey and Christian (2002, 44) are that in the first three years after publication, all economics articles in the SCI/SSCI are cited on average 1.08 times; articles published by authors affiliated with institutions in the United States are cited 1.35 times. These figures convert to 0.36 and 0.45 per article per year. Hence IMPACT papers are cited 175 percent and 120 percent more frequently than economics papers in the world and the United States, respectively.

**Table 2. Citations of papers using IMPACT framework**

Paper	Years since publication	Number of citations <sup>a</sup>	
		Per publication	Per publication per year
Huang, J., S. Rozelle, and M. W. Rosegrant. 1999. China's food economy to the 21 <sup>st</sup> century. <i>Economic Development and Cultural Change</i> 47(4): 737–766.	2.42	5 (9)	2.07
Rosegrant, M. W., and C. Ringler. 1997. World food markets into the 21 <sup>st</sup> century: Environmental and resource constraints and policies. <i>Australian Journal of Agricultural and Resource Economics</i> 4(3): 401–428.	4.25	4 (4)	0.94
Rosegrant, M. W., N. Leach, and R. V. Gerpacio. 1999. Alternative futures for world cereal and meat consumption. <i>Proceedings of the Nutrition Society</i> 58(2): 219–234.	2.58	4 (11)	1.55
Rozelle, S., and M. W. Rosegrant. 1997. China's past, present, and future food economy: Can China continue to meet the challenges? <i>Food Policy</i> 22(3)(June): 191–200.	4.50	2 (6)	0.44
Delgado, C. L., M. W. Rosegrant, H. Steinfeld, S. Ehui, and C. Courbois. 2001. Livestock to 2020. The next food revolution. <i>Outlook on Agriculture</i> 30 (1): 27–29, March.	0.75	1 (8) <sup>b</sup>	1.33
Scott, G. J., M. W. Rosegrant, and C. Ringler. 2000. Global projections for root and tuber crops to the year 2020. <i>Food Policy</i> 25(5): 561–597.	1.17	1 (13)	0.85
Rosegrant, M. W., and C. Ringler. 2000. Asian economic crisis and the long-term global food situation. <i>Food Policy</i> 25(3)(June): 243–254, Special issue on Policy Reform, Market Stability and Food Security.	1.50	0 (12)	0
<b>Averages</b>	2.45	2.43 (9)	0.99 (3.67)

Source: Derived by the author from the databases.

<sup>a</sup> The figures in parentheses refer to the citations in the Web of Science database. The others refer to those from the SCI/SSCI database.

<sup>b</sup> The Web of Science citations refer to the similar paper published in *CHOICES* (Delgado et al. 1999).

<sup>10</sup> A comparison of the citations of the published work and “grey literature” of IFPRI with other modeling groups such as FAO, FAPRI, Economic Research Service (ERS)/USDA would have been informative. These are alternative suppliers of agricultural projections and as such offer a more relevant benchmark for the IFPRI-IMPACT framework. However, the fact that citations of the primary IMPACT publications in the refereed professional literature outperformed the general economics literature in both the U.S. and the world by a factor of more than two times is a compelling statistic that suggests IMPACT would compare well with its competitors.

A new database has recently become available from the Web of Science. It has the advantage that it covers not only citations in journal articles but also in books and reports. The Web of Science database contained an average of nine citations of each of the same seven IMPACT papers, more than three times the number of refereed journal citations. To the extent that policymakers and analysts are more likely to consult books and reports than journals, the contrast suggests these IMPACT outputs are consulted and used by an informed and influential audience. Unlike SCI/SSCI, we do not have Web of Science citations for all IFPRI publications to compare with those involving the IMPACT framework.

The preface to the WB's new strategy on livestock development (de Haan et al. 2001, p. viii) illustrates the influence of one recent IMPACT publication. The preface says Delgado et al. (1999) was one of the three important building blocks for the book. The book draws on the livestock projections and other insights in Delgado et al. to urge the WB and other international agencies to make a major adjustment in the priority they accord to livestock in recognition of its contribution to poverty alleviation, environmental sustainability, and food security. The WB's livestock project portfolio is currently around \$1.9 billion and its Senior Livestock Advisor continues to cite more recent updates of the Delgado et al. (1999) livestock projections to help focus and reinforce the WB's livestock strategy. Hence although the journal version of the IMPACT livestock projection work received only one citation (Table 2), the unabridged IFPRI/ILRI/FAO publication was quite influential in international research and development (R&D) priorities and strategies.

The livestock projections in Delgado et al. (1999) were adopted and used by the U.S. Council on Agricultural Science and Technology (CAST) in its task force report on "Animal Agriculture and Global Food Supply." Two IFPRI contributors to the 2020 report were also co-authors of the CAST publication. The findings in Delgado et al. (1999) have been cited extensively in the strategic and medium-term plans of ILRI, FAO, United States Agency for International Development (USAID) and the Department for International Development (DfID). Documentation can be found on the ILRI website ([www.ilri.org](http://www.ilri.org)), the FAO/WB website for the "Livestock and Environment" initiative ([www.lead.virtualcentre.org](http://www.lead.virtualcentre.org)), and in the document "Pro-poor Livestock Policy Initiative: Project Memorandum" submitted by FAO to DfID in 2001. DfID has agreed in principle to provide seed money of £9 million for this initiative, which FAO has costed worldwide at £24 million over six years.

### **The Demand for IMPACT Publications**

Another indicator of the IMPACT framework's value is the extent of demand for the various publications that have emerged from the program. These are publications that IFPRI has produced, as opposed to the journal papers in the foregoing citation analysis. Two measures were used to reflect this demand. The first measure comprised written and online requests received by IFPRI's Communications Division for hard copies of the major publications. The second measure comprised download statistics from the IFPRI website. These data are shown in Table 3.<sup>11</sup>

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<sup>11</sup> I am grateful to Shereese Lawson and Evelyn Banda in IFPRI's Communications Division for compiling these data. These data exclude the many thousands of copies dispatched to those on the various regular IFPRI mailing lists, including that of the 2020 Vision, which has been a primary

## Box 2. Peer Recognition

### World Food Prize

Arguably the most significant recognition of the worth of the IMPACT framework is the award of the World Food Prize in 2001 to Per Pinstrup-Andersen, Director General of IFPRI. The citation reads in part: "...Dr. Per Pinstrup-Andersen has been the driving force in pressing forward a global effort—The 2020 Vision Initiative—to assist world leaders focus on the potential for food security crises in the 21<sup>st</sup> Century. Ambassador Quinn described this effort as a 'brilliant catalyst for policy change, which moved food policy issues to the forefront of the international agenda, and resulted in improved food security for millions.'" The IMPACT framework has provided the analytical foundation for the 2020 Vision Initiative and can justifiably claim reflected recognition in the award to Pinstrup-Andersen.

### AAEA Award

The American Agricultural Economics Association (AAEA) awarded Per Pinstrup-Andersen, Rajul Pandya-Lorch, and Mark Rosegrant the Distinguished Policy Contribution Award in recognition of superior achievement in July 2002. The executive summary of the citation accompanying the Award reads:

*Three members of the American Agricultural Economics Association — Per Pinstrup-Andersen, Rajul Pandya-Lorch, and Mark Rosegrant — created and implemented the 2020 Vision initiative for Food, Agriculture, and the Environment, an initiative that has made tremendous contributions to food, agriculture, and environment policy during the last five years. In fact, it continues to do so. Per Pinstrup-Andersen, IFPRI's Director General, created, conceptualized, developed, and provided direction and leadership to the 2020 Vision initiative. The initiative's research, communications, and capacity-strengthening activities are coordinated by Rajul Pandya-Lorch, Head of the 2020 Vision Initiative. Mark Rosegrant leads the development and maintenance of IFPRI's 2020 global projections model—International Model for Policy Analysis on Commodities and Trade (IMPACT)—which underpins the initiative and is recognized as one of the world's premier models for long-term projections of global food demand, supply, and trade as well as child malnutrition.*

*Together, these three individuals created, conceptualized, designed, and implemented a cohesive set of activities that generated new research results, packaged, presented, and disseminated these results and already existing empirical evidence in a way that enlightened the debate and influenced policy decisions both internationally and in a large number of countries, while adding to the general knowledge about policies related to food, agriculture, and the environment. In addition to hundreds of papers and presentations made by the three individuals during the last five years, they mobilized a large number of people and institutions to work with them to further generate and disseminate new policy knowledge and a much larger number of policymakers and other potential users of such knowledge to incorporate the knowledge into the debate and decisionmaking. Innovative communications approaches combined with sound, relevant, and timely information and a personal commitment to the initiative by each of the three contributed to the successful contributions to policy. Adoption of some of these approaches such as the preparation of crisp policy briefs has been widespread in national and international institutions, presumably adding to the policy contributions of those institutions as well. The rest of this note presents evidence of selected policy contributions and results from external assessments of impact.*

The most demanded IFPRI IMPACT publications were those that addressed global food projections in 1997, 1999, and 2001 (Table 3). The 1999 publication (Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1999) was requested almost twice as much as the second ranked publication (Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1997). It was also by far the most popular publication downloaded from the web. If the third-ranked publication of Rosegrant et al. (2001b) is combined with its unabridged version listed sixth (Rosegrant et al. 2001a), together they rank first in

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communication vehicle with more than 4,000 recipients. They also excludes mailings by collaborating institutions such as CIP and ILRI. There is no good record of the total number of copies dispatched to these various mailing lists. To the extent that in impact evaluation we are primarily interested in demand for publications as an indicator of outcomes and influence rather than supply or output per se, the lack of information on the latter is not critical.



hard copy requests and web downloads per month and second in total requests. There was a substantial demand for the Delgado et al. (1999) publication, which was fourth on the list.

The publications that addressed specific regions or commodities were much less in demand, which is perhaps to be expected. Overall, the total requests satisfied by dispatch of hard copies (16,777) were 58 percent of those satisfied by web downloads (28,876). The ranking of publications based upon download statistics was slightly different when the totals since the publications became available to download were used, compared to the averages per month (Table 3).

A comparison was done of the frequency with which the IMPACT publications listed in Table 3 were in the top three of all the IFPRI publications downloaded from the IFPRI website in the period since January 2000. In the six months it had been available on the website, the publication by Rosegrant et al. (2001b) has been in the top three all of the time. This is closely followed by Pinstруп-Andersen, Pandya-Lorch, and Rosegrant (1999), which has been in the top three for 19 of the 25 months it has been available. No other IFPRI publication approaches these figures. The next best performer is the set of 2020 Visual Slides, which appeared in the top three for seven of the 19 months it has been on the web.

**Table 3. Requests for IFPRI IMPACT publications**

Title	Hard copy requests <sup>a</sup>	Web downloads <sup>b</sup>	Total
1. Pinstруп-Andersen, P., R. Pandya-Lorch, and M. W. Rosegrant. 1999. <i>World food prospects: Critical issues for the early twenty-first century</i> . 2020 Vision Food Policy Report. Washington, D.C.: IFPRI, October.	4,044	10,853 (434)	14,897
2. Pinstруп-Andersen, P., R. Pandya-Lorch, and M. W. Rosegrant. 1997. <i>The world food situation: Recent developments, emerging issues, and long-term prospects</i> . 2020 Vision Food Policy Report. Washington, D.C.: IFPRI, December.	3,408	4,176 (167)	7,584
3. Rosegrant M. W., M. S. Paisner, S. Meijer, and J. Witcover. 2001b. <i>2020 global food outlook: Trends, alternatives and choices</i> , 2020 Vision Food Policy Report. Washington, D.C.: IFPRI.	1,985	5,371 (895)	7,356
4. Delgado, C. L., M. W. Rosegrant, H. Steinfeld, S. Ehui, and C. Courbois. 1999. <i>Livestock to 2020. The next food revolution</i> . 2020 Vision for Food, Agriculture, and the Environment Discussion Paper No. 28. Washington, D.C.: IFPRI (co-published with ILRI and FAO).	3,350	3,797 (152)	7,147
5. Scott, G. J., M. W. Rosegrant, and C. Ringler. 2000a. <i>Roots and tubers for the 21st century: Trends, projections, and policy options</i> . 2020 Vision for Food, Agriculture, and Environment Discussion Paper No. 31. Washington, D.C.: IFPRI.	1,071	2,554 (122)	3,625
6. Rosegrant M. W., M. S. Paisner, S. Meijer, and J. Witcover. 2001a. <i>Global food projections to 2020: Emerging trends and alternative futures</i> . 2020 Vision, Washington, D.C.: IFPRI.	2,117	662 (166)	2,779

**Table 3. Requests for IFPRI IMPACT publications**

Title	Hard copy requests <sup>a</sup>	Web downloads <sup>b</sup>	Total
7. Rosegrant, M. 1997. <i>Water resources in the twenty-first century: Challenges and implications for action</i> . 2020 Vision for Food, Agriculture and the Environment Discussion Paper 20. Washington, D.C.: IFPRI	555	1,463 (59)	2,018
8. Rosegrant, M. W., J. Huang, and S. Rozelle. 1997. <i>China's food economy to the 21st century: Supply, demand and trade</i> . 2020 Vision Food, Agriculture and Environment Discussion Paper No. 19. Washington, D.C.: IFPRI.	247	n.a.	247
Totals	16,777	28,876 (220)	45,653

n.a. indicates not available.

Source: Compiled by the author.

<sup>a</sup> Includes those received by mail and online up until January 2002.

<sup>b</sup> Web downloads became possible on the IFPRI website in January 2000. The statistics refer to the number of downloads from when each publication became available on the web until January 2002. The figures in parentheses are the average downloads per month in the period since the publications became available on the web, which differed in each case. It is arguably a better reflection of demand than the totals over the whole period outside the parentheses.

## Communications and the Media

The print, radio, and television media have all been extensively employed to convey the messages that have emerged from the various IMPACT analyses and publications. This has heightened in recent years, significantly because of the importance of the IMPACT modeling work to IFPRI's 2020 Vision for Food, Agriculture, and the Environment initiative. In particular, the global food projections work using the IMPACT framework has been a major ingredient. Paarlberg (1999) describes this in more detail.

A review of the media coverage following the August 2001 Conference sponsored by the IFPRI 2020 Vision initiative revealed the following frequencies of items that mentioned the publication by Rosegrant et al. (2001a) and the IMPACT modeling results prepared especially for the Conference:

- International press services 16
- Major newspapers 5
- Internet news outlets 4

Numerous other media interviews have been aired and printed and press conferences held where IMPACT results were highlighted. These included a press conference at the National Press Club broadcast live by C-SPAN in Washington, D.C. and one in Berlin. Print coverage of the 2020 Conference in Germany alone comprised 174 articles in print media with a total circulation of 36 million. It is not known what proportion actually referred to IMPACT projections, but it is likely most would have.

The release of the book by Rosegrant and Hazell (2000), which included the Asian IMPACT projections, was covered by India's largest news agency, the Press Trust of India. PTI subscribers include 450 newspapers in India and abroad, including international agencies such as the BBC.

Presentations by IMPACT researchers and senior IFPRI management at national and international conferences, symposia, workshops, and seminars have contributed to the effective communications strategy associated with the applications of the IMPACT framework. More than 151 such presentations were made from 1995 to the end of 2001. The audiences have included donors, governments, bureaucrats, academics, and students in both developing and developed countries. In addition, of the 78 meetings of the 2020 Vision initiative that have been held since 1994, some 34 (43 percent) have included sessions using projections from the IMPACT framework.

Public conferences at the time of release of the livestock paper (Delgado et al. 1999) were given by IFPRI staff in the United States, Italy, France, Germany, the United Kingdom, Ethiopia, the Philippines, New Zealand, Uruguay, and Brazil. Briefings were given to the President of France; to Ministers of Agriculture in Brazil, Germany, and Uruguay; to select committees of the U.S. Senate and House of Representatives; and to the White House Office of Science and Technology Policy. An IFPRI staff member delivered a plenary address at International Centers Week in 1999 during an ILRI time period.

### **Derived Demand**

Invitations, requests to use the model, translations of publications, and voluntary feedback provide further perspective about the influence of the IMPACT framework. They reflect a proactive response by otherwise passive recipients of publications and/or those who attend presentations. There are many such examples and anecdotes.

In 1998, an economic consulting firm in the United States prepared a report for USAID on the cost of meeting the World Food Summit target of halving world hunger by 2015. They relied on the IMPACT model projections and were provided with access to hitherto unpublished results to prepare their report. They updated the analysis for USAID in 2001, which included the effects of the HIV/AIDS pandemic. The report was shared with FAO, which was interested in it for the World Food Summit + 5, and the nongovernmental organization (NGO) Bread for the World, which used it effectively in its U.S. lobbying activities aimed at enhancing world food security.

The WB requested Mark Rosegrant to employ the IMPACT framework to assess the long-term implications for food security and development of changes in major agricultural and natural resource base variables. This work was recently published by the WB (Rosegrant, Paisner, and Meijer 2001a). The results were used to inform the development of a new WB strategy on rural development. Other requests for model runs have come from the Department of Foreign Affairs and Trade (DFAT) in Canberra, Australia; the Overseas Development Institute; World Water Vision; Monsanto; and the World Food Programme. The DFAT request required

major adjustments due to the addition of fruits, vegetables, sugar, and sweeteners to the commodity coverage. It resulted in a paper by Rosegrant, Paisner, and Meijer (2001b).

As mentioned earlier, Peter Hazell and Mark Rosegrant were invited by the ADB to contribute to the development of its new Asian rural strategy. The IMPACT framework was employed to assess various scenarios. The recommendations of the IFPRI component found their way into the ADB overview report (Asian Development Bank 2000). Indeed, Hazell and Rosegrant were asked to prepare the first draft of the overview report, which was reviewed by ADB staff. This followed the international workshop in 1999, which reviewed all five background papers, of which the IFPRI paper was one.

The Nutrition Society invited Mark Rosegrant to present a plenary paper at its annual meeting in 1999. The result was the paper published by Rosegrant, Leach, and Gerpacio (1999), which subsequently received around 25 requests for reprints. The paper was well received by the primarily noneconomist audience. Many participants were surprised by and a few unhappy with the finding that reducing meat consumption in developed countries is not an effective way to improve food security in developing countries. Needless to say, Rosegrant and colleagues were able to give important insights to a major group in a related profession and also enhance the IFPRI effort, led by the Food Consumption and Nutrition Division, to be a respected participant in the nutrition community.

A reporter with *New Scientist* magazine asked Rosegrant to what extent the IMPACT model projections allowed for the effects of climate change. The reporter was writing an article based on a UNEP press release stating that yields of rice, wheat, and maize in the tropics could decline by more than 20 percent as a result of temperature increases of about 2 degrees Celsius over the next 100 years. Rosegrant was able to advise her that there is no scientific consensus about the rate of temperature increases and that since the IMPACT model only projects to 2020, the net effect of global climate change on yields was likely to be positive since the effects of increased carbon fertilization would offset the direct effect of any atmospheric warming during this time frame. These types of clarifications offer reality checks on projections of others. The China case mentioned earlier provides another example.

In 2001, a Vietnamese water resource planner highlighted IMPACT projections in a presentation to the National Water Resources Council in Hanoi on future water-agriculture scenarios. The focus was on the role of rice in future food demand patterns. The projections of declining world prices of rice and increased demand for maize as a feedgrain were regarded as especially relevant to decisions about rice self-sufficiency and the need for crop diversity.

Other examples where the IMPACT framework stimulated the development of country-level food supply/demand models that used the methodology and involved collaboration include India (Kumar and Rosegrant 1995 and 1997), Indonesia (San, Rosegrant, and Perez 1998), and Nepal (Thapa and Rosegrant 1995).

A survey of the participants in the 2020 Conference in Bonn, Germany, on “Sustainable Food Security for All by 2020” in September 2001 revealed that a significant number regarded the information provided on the extent and causes of food insecurity in the papers by Rosegrant et al. (2001a and 2001b) as providing new information and insights (Ryan 2002b). It was the fourth most frequently cited example of new insights from a total of 18, after the effects of globalization and trade liberalization, climate change, and the importance of political will. It was also the fifth most mentioned highlight of the Conference among 46 highlights cited by participants. The four mentioned more frequently referred to the conference program and the quality of speakers, presentations, and discussions.

Two contributions to the forthcoming 2002 book *Ending Hunger in the 21<sup>st</sup> Century: Rethinking Food Security and Globalization* (by the IMPACT team in collaboration with Bread for the World and the University of Minnesota) will soon be completed. The IMPACT model was used in the chapters “Sustainability and Hunger: A Global Perspective” and “Investing in Sustainability.” Issues addressed in these chapters include land availability and quality, genetic-based agricultural yield growth, and the roles of biotechnology, chemical fertilizers, water scarcity and quality, and global climate change.

The paper by Delgado et al. (1999) was translated into Japanese independently and at their own expense by the Japan Livestock Technology Association. ILRI had translated it into French. The associated IFPRI brief on this publication has been informally translated into German and Portuguese by third parties.

There have been numerous requests to the IMPACT team to write short articles for various newsletters highlighting future projections. One example is from the editor of *Population Today*, published by the Population Reference Bureau.

An increasing number of requests for access to the IMPACT model software and documentation have led to a recent decision by IFPRI to make it available on the IFPRI website. This will make it more accessible and closer to an international public good. There have also been many requests for the projection outputs for individual countries and years when these have not been included in published form. Generally these requests have been responded to positively.

As a follow-up to the publication of Delgado et al. (1999), a collaborative project involving IFPRI, ILRI, and institutions in the Philippines, Kenya, and Bangladesh has begun under the auspices of the System-wide Livestock Program of the CGIAR. It aims to determine the technical, institutional, infrastructural, policy, and regulatory factors encouraging the displacement of smallholder livestock raisers in peri-urban areas by large producers. The project is being extended to other countries in collaboration with FAO, and this has led to an invitation to IFPRI to join the Steering Committee of the Livestock and the Environment initiative.

The IMPACT framework has led to significant interinstitutional collaboration. Examples include research on livestock (ILRI/FAO), fisheries (International Center for Living Aquatic Resources Management [ICLARM]/FAO), roots and tubers (CIAT/CIP/IITA), semi-arid tropical commodities (International Crops Research

Institute for the Semi-Arid Tropics [ICRISAT]), and water (International Water Management Institute [IWMI]). It has also served as a vehicle for collaboration across divisions within IFPRI. Besides the earlier work on livestock with the Markets and Structural Studies Division, there is ongoing analysis of the prospects for fisheries with the same division and an analysis of dietary patterns and calorie consumption with the Food Consumption and Nutrition Division.

## 4. PERCEPTIONS OF VALUE AND IMPACT

### Survey and Questionnaire

To complement the information on tangible indicators of the outcomes and influence of the IFPRI research on the IMPACT model and the various applications on which it has been employed, a mail survey was undertaken. A questionnaire was developed to elicit the views of some 246 potential users of such information.<sup>12</sup> It was sent out with an accompanying letter and a list of the 15 most representative IMPACT publications (Appendix 2). The survey list included donors/international organizations, international agricultural research centers, national agricultural research systems, consultants/private sector, academics from developed and developing countries, and NGOs (Table 4). Some 93 percent of the forms were sent by e-mail, 5 percent by fax, and 2 percent by mail. A list of those who responded and others who were interviewed by the author is shown in Appendix 3.

There were 43 responses (17.5 percent).<sup>13</sup> Of these, six indicated they were not familiar with the IMPACT publications and did not complete the questionnaire. Another respondent indicated s/he did not complete the questionnaire but did in fact use the IMPACT projections. Developed-country academics had the best response rate, followed by those from developing countries, although not many academics were involved in the survey. There was a good response rate from the international centers and donors/international organizations. A synthesis of the responses follows.

**Table 4. Statistics on survey and the responses**

Type of institution	Number of questionnaires:		Response rate (%)
	Sent out	Returned	
Donors/international organizations	85	13	15.3
International centers/TAC(Technical Advisory Committee)	69	16	23.2
NARS <sup>a</sup>	45	4	8.9
NGOs	21	1	4.8
Consultants/private sector	15	2	13.3
Developed country academic	9	6	66.7
Developing country academic	2	1	50.0
Total	246	43	17.5

Source: Derived by the author from the survey.

<sup>a</sup> Includes regional and global research organizations and developed and developing country NARS.

<sup>12</sup> The initial mailing comprised 228 surveys. In answer to questions 15 and 16, an additional 18 names were suggested by initial respondents. Hence there were 18 in the second mailing. Sixteen of these were thought to have found the IMPACT publications useful and two were expected to be critical, according to respondents who answered the two questions concerned. The author also interviewed a number of senior economics researchers and advisors in China, and a number of participants in the Annual General Meeting of the CGIAR in Washington, D.C. in 2001.

<sup>13</sup> Of the 43, 40 came from the first mailing and three from the second.

## Survey Responses

### *Familiarity with IMPACT Framework*

Questions 6–8 refer to the extent to which respondents were familiar with the IMPACT publications and could cite instances where they had been surprised by the information provided. The summary of responses to questions 6 and 8 are shown in Table 5 and those for question 7 in Table 6.

**Table 5. Familiarity with IMPACT framework**

Question	International centers			Donors/ international organizations			Others <sup>a</sup>			Total		
	Yes	No	n.a.	Yes	No	n.a.	Yes	No	n.a.	Yes	No	n.a.
6. Have you read or consulted IMPACT publications?	14	0	0	9	2	0	10	1	0	33	3	0
8. Was there any new and/or surprising information in any of the publications?	8	4	2	7	2	2	8	1	2	23	7	6

n.a. means no answers given.

Source: derived by the author from the survey.

<sup>a</sup> Combines national agricultural research systems, consultants, private sector, academics, and NGOs.

The vast majority of respondents had consulted IMPACT publications, and almost two-thirds had found new and/or surprising information in them. Among the examples provided by respondents were:

- changes in growth rate projections;
- projections that livestock product deficit countries will import feed rather than meat, which contradicts trade theory that higher value products are traded;
- the fact that millennium development goals will remain challenges in Sub-Saharan Africa and South Asia until 2020;
- significant demand-led growth expected in meat consumption in developing countries and the fact that this will not place undue upward pressure on grain prices;
- the importance of local production in meeting increased demand for milk and meats in developing countries with consequences for smallholders in those countries relative to large commercial producers in developed countries;
- trade projections for cereals and the expected decline in prices of cereals;
- effects of changes in policies, technologies, and lifestyles on global and regional projections;
- the effects of changes in demand patterns for meat in India;
- new and updated projections;
- limited nutritional impacts expected from future projections and the effects of alternative scenarios on child malnutrition;
- global perspective;
- detailed assessment of China's future prospects, especially meats;



- lack of consideration of the role of wildlife in future meat scenarios; and
- the breadth of consideration given to aspects such as health and political influences on future projections.

One respondent who has been responsible for developing models for commodity projections in an international organization was especially complimentary of the IFPRI IMPACT framework. Even though he indicated that he had found no new or surprising information in the IMPACT publications, he went on to add:

**Table 6. IMPACT publications most frequently read by respondents**

Publication <sup>a</sup>	International centers		Donors/ international organizations		Others		Total	
	No.	Rank	No.	Rank	No.	Rank	No.	Rank
Rozelle, S., J. Huang, and M. Rosegrant. 1996. Why China will not starve the world. <i>CHOICES</i> 18–25, First Quarter.	2	4	1	5	4		7	6
Fan, S., and M. Agcaoili-Sombilla. 1997. Why projections on China's future food supply and demand differ. <i>The Australian Journal of Agricultural Economics</i> 41(2): 169–190, June.	0		1	5	5	4	6	7
Pinstrup-Andersen, P., R. Pandya-Lorch, and M. W. Rosegrant. 1997. <i>The world food situation: Recent developments, emerging issues, and long-term prospects</i> . 2020 Vision Food Policy Report. Washington, D.C.: IFPRI, December.	6	2	7	2	10	1	23	1
Rosegrant, M. W., and C. Ringler. 1997. World food markets into the 21 <sup>st</sup> century: Environmental and resource constraints and policies. <i>Australian Journal of Agricultural and Resource Economics</i> 4(3): 401–428.	1	4	2	4	3	6	6	7
Rosegrant, M. W., J. Huang, and S. Rozelle. 1997. <i>China's food economy to the 21<sup>st</sup> century: Supply, demand, and trade</i> . 2020 Vision Food, Agriculture and Environment Discussion Paper No. 19. Washington, D.C.: IFPRI.	0		2	4	2	7	4	8
Rozelle, S., and M. W. Rosegrant. 1997. China's past, present, and future food economy: Can China continue to meet the challenges? <i>Food Policy</i> 22(3): 191–200.	1	4	1	5	4	3	6	6
Rosegrant, M. W., and C. Ringler. 1998. Impact on food security and rural development of transferring water out of agriculture. <i>Water Policy</i> 1(6): 567–586.	1	4	1	5	0		2	8

**Table 6. IMPACT publications most frequently read by respondents**

Publication <sup>a</sup>	International centers		Donors/ international organizations		Others		Total	
	No.	Rank	No.	Rank	No.	Rank	No.	Rank
Delgado, C. L., M. W. Rosegrant, H. Steinfeld, S. Ehui, and C. Courbois. 1999. <i>Livestock to 2020: The next food revolution</i> . 2020 Vision for Food, Agriculture and the Environment Discussion Paper No. 28. Washington, D.C.:IFPRI, ILRI, and FAO co-publication.	6	2	7	2	7	2	20	2
Huang, J., S. Rozelle, and M. W. Rosegrant. 1999. China's food economy to the twenty-first century: Supply, demand, and trade. <i>Economic Development and Cultural Change</i> , 737–766.	2	3	1	5	4	3	7	5
Pinstrup-Andersen, P., R. Pandya-Lorch, and M. W. Rosegrant. 1999. <i>World food prospects: critical Issues for the early twenty-first century</i> . 2020 Vision Food Policy Report. Washington, D.C.: IFPRI, October.	7	1	5	3	9	1	21	1
Rosegrant, M. W., N. Leach, and R. V. Gerpacio. 1999. Alternative futures for world cereal and meat consumption. <i>Proceedings of the Nutrition Society</i> 58(2): 219–234.	0		1	5	0		1	9
Rosegrant, M. W., and C. Ringler. 2000. Asian economic crisis and the long-term global food situation. <i>Food Policy</i> 25(3), special issue on Policy Reform, Market Stability and Food Security.	0		1	5	0		1	9
Scott, G. J., M. W. Rosegrant, and C. Ringler. 2000. Global projections for root and tuber crops to the year 2020. <i>Food Policy</i> 25(5): 561–597.	1	4	2	4	1	4	4	7
Rosegrant, M. W., M. S. Paisner, S. Meijer, and J. Witcover. 2001. <i>2020 global food outlook: Trends, alternatives, and choices</i> . 2020 Vision Food Policy Report. Washington, D.C.: IFPRI, August.	3	3	7	2	7	2	17	3
Rosegrant, M. W., M. S. Paisner, S. Meijer, and J. Witcover. 2001. <i>Global food projections to 2020: Emerging trends and alternative futures</i> . 2020 Vision. Washington, D.C.: IFPRI, August.	6	2	8	1	1	4	15	4

Source: Derived by the author from the survey.

<sup>a</sup> This is the list of publications that accompanied the questionnaire as shown in Appendix 2. Three respondents nominated a total of three IMPACT publications that were not in the list: Rosegrant, Agcaoili-Sombilla, and Perez (1995), Delgado, Rosegrant, and Meijer (2001), and Evenson and Rosegrant (forthcoming).

*“Not surprising so much as comforting information, as the fact that the modelers have taken factors such as changing income elasticities, changes in diets as incomes change, and urbanization into account leads, I believe, to much more realistic projections. Other modelers have not been so comprehensive in their analytical frameworks.”*

The most popular publication was Pinstруп-Andersen, Pandya-Lorch, and Rosegrant (1997), closely followed by Pinstруп-Andersen, Pandya-Lorch, and Rosegrant (1999) and Delgado et al. (1999) (Table 6). All were published by IFPRI. These ranks are consistent with those in Table 3 on the number of requests IFPRI has received for IMPACT publications. The three least popular publications by respondents were all professional journal articles (Rosegrant, Leach, and Gerpacio 1999; Rosegrant and Ringler 2000a and 2000b). This suggests that those in the national and international R&D communities rely primarily on IFPRI publications for information on the IMPACT framework and its applications. Professional papers do not rate as highly in this respect. This implies that the types of communication vehicles that maximize IFPRI’s institutional influence on policy outcomes may not be coincident with those that are in the best professional interests of its researchers.

### ***Use and Influence***

Questions 9–12 refer to the use to which respondents put the information gleaned from IMPACT publications and their influence on policy, research, and teaching. The results are summarized in Table 7.

In general, the information from IMPACT publications has been used extensively in the research programs of respondents and to a lesser extent in a policy context. A minority used them in teaching programs. However, for many respondents, teaching was not a responsibility in their positions and few high-level policymakers responded, so this result is not surprising. In the international centers, research was by far the primary use for the information, with very little being employed in a policy context. The reverse was true in donor and other international organizations. The “Other” category of respondents used the material more evenly across the three themes.

**Table 7. Use and influence of IMPACT publications**

Questions	International centers			Donors/ international organizations			Others			Total		
	Yes	No	n.a.	Yes	No	n.a.	Yes	No	n.a.	Yes	No	n.a.
9. Have you used information from IMPACT publications: (a) In a policy context?	2	11	1	8	2	1	6	5	0	16	18	2
(b) In your research?	12	1	1	2	5	4	7	4	0	21	10	5
(c) In your teaching?	0	8 <sup>a</sup>	6 <sup>a</sup>	2	3	6	4	4	3	6	15	15
10. Has IMPACT modeling information been influential in formulating policies or strategies in your institution?	7	6	1	7	3	1	2	8	1	16	17	3
11. What other sources besides the IMPACT publications have you used for projections?	FAO (6) <sup>b</sup> , World Bank (3), USDA (1), World Grain Council (1), OECD (1), UNDP (1), IWMI (1), TAC (1), CAST (1), Other (3), No others (3)			FAO (5), WB (2), IMF (1), AOAD (1), CGE (1), CARD (1), BRS (1), GTAP (1), No others 6			WB (4), FAO (3), USDA/ERS (2), CCAP/CAPSim (2), TDB (1), HBR (1), ARMA/ARIMA (1), Other (1), No others (3)			FAO <sup>c</sup> (14), WB (9), USDA/ERS (3), CCAP/CAPSim (2), No others (12)		
12. How influential have they been?	6	5	1 (2) <sup>d</sup>	4	1	0 (6)	0	40	3 (3)	10	10	4 (11)

Source: derived by the author from the survey.

n.a. indicates no answer given.

<sup>a</sup> Most respondents in this category did not have teaching responsibilities so the “no” and “n.a.” answers should both be interpreted as “not applicable.”

<sup>b</sup> Numbers in parentheses represent the frequency of citations of other references by respondents.

<sup>c</sup> Only those having more than one citation are listed here.

<sup>d</sup> The figures in parentheses refer to the frequency on “no” answers. The other three figures refer to the frequency of “very influential,” “somewhat influential,” and “not influential,” respectively.

Centers that used IMPACT materials for policy mostly employed it in strategic planning and priority assessment and in discussions with donors. The IMPACT information also was cited in many centers’ research publications, such as those on commodity facts and trends, natural resource degradation issues, and implications. Donors and other international organizations used the material in advocacy for increased public investment in agricultural research, global and regional livestock strategy formulation, aid and trade priorities, inclusion in briefing notes for ministers, papers for presentations, public awareness documents, influencing policies and priorities on food security, and advice to regional offices. Institutions in the “Other” category used the publications in meetings and workshops, citations in

national and provincial reports, discussions with policymakers about priorities, and policy briefs to premiers and ministers. There were at least nine citations of IMPACT publications in peer-reviewed papers published by the “Other” respondents. In addition, there were a number of conference papers with citations. Courses where the material was used included political science, development economics and policy, social development and economic planning, agribusiness management, agricultural industry economics, and people and the environment.

The centers have found the IMPACT materials of more relevance to the formulation of internal policies and strategies than external ones, judging from a comparison of questions 9(a) and 10 (Table 7). This has mostly been in the context of establishing priorities using the various commodity projections. Donors and international organizations have used the information as much for policy purposes internally as externally. This has included research prioritization, rural strategy formulation, background for decisionmaking, and public awareness about the continuing challenge of food security. One donor found the livestock papers especially helpful in determining the agency’s attitude to the role of smallholders in future livestock strategies. Another major donor agency indicated the IMPACT model had a significant impact in shaping its policy toward global food security and in program strategies, although it was less helpful on China. Three examples of the influence on programs were the case for convincing legislators to strengthen the agency’s African program, the magnitude of opportunities in developing and transition economies for livestock development efforts, and the development resources needed to meet the goals of the World Food Summit. The “Other” category institutions did not use IMPACT materials extensively in internal policy matters.

A total of 22 other sources of information on projections besides those using IMPACT were referred to by respondents in answer to question 11 (Table 7). By far the most common alternatives were FAO and the WB. The vast majority felt that the alternatives to IMPACT had been either somewhat or very influential (question 12, Table 7). Only 17 percent felt they had had no influence.

### ***Assessment of IMPACT Framework***

Questions 13–17 refer to the assessment of respondents of the worth of the IMPACT framework in comparison to alternatives and their knowledge of the attitude of colleagues. A summary of the responses appears in Table 8.

#### **Box 3. Influence in China**

The influence of the IMPACT framework in China in the period after Lester Brown published his book *Who Will Feed China? Wake-up Call for a Small Planet* in 1995 is instructive. It came at a time of a record import of grains by China in 1994 and 1995 and substantial increases in world prices. The relative lack of analytical capacity in China at that time to understand trends, influences, trade-offs, and policy options was exposed by Brown’s emotive book. “The ensuing panic in China’s agricultural hierarchy, however, could not be suppressed since no research team inside or outside of China could respond authoritatively.” (Huang, Rozelle, and Rosegrant 1999, p. 738). Policies aimed at grain self-sufficiency were reinforced as a result, including increasing procurement prices above world market levels, offering incentives to farmers to reduce production of cotton and oilseed crops, and introducing the “Governor’s Grain Bag Responsibility System” (Fan and Cohen 1999). This held provincial governors responsible for balancing grain supply and demand and stabilizing grain prices within their provinces. It amounted to promotion of regional self-sufficiency.

These and other policy responses after the Brown book led to record grain harvests, increased stocks, and

minimal imports in the late 1990s. Arguably this led to increased land degradation as grain cultivation was expanded to marginal environments in many provinces in the quest for regional self-sufficiency. Increasing dust storms have resulted.

The influence of the IMPACT framework in China has been both direct and indirect. The latter has been more significant according to discussions with senior agricultural economists in China. The indirect effect has primarily been through use of the CAPSim model within CCAP. This model was an outgrowth of the earlier collaboration between the current Director of CCAP and IFPRI staff involved in the development of the IMPACT framework in the mid-1990s, which led to a number of publications (Rozelle, Huang, and Rosegrant 1996; Rozelle and Rosegrant 1997; Huang, Rozelle, and Rosegrant 1997 and 1999). Since then, the CAPSim model has been further refined by Huang and his colleagues at CCAP.<sup>14</sup> It appears more Chinese policymakers are aware of CAPSim and its outputs than are aware of the IMPACT framework and publications related to it.<sup>15</sup> One significant reason offered to the author was that CCAP translates its policy briefs into Chinese, whereas IFPRI does not. Indeed, a Chinese summary of the paper by Huang, Rozelle, and Rosegrant (1999) was given to Premier Zhu Rongji. CCAP also was invited to give seminars to policymakers about their research conclusions. CAPSim is currently being further developed into a decision support system for the Ministry of Agriculture, Ministry of Science and Technology, the state Economic Development and Planning Commission, and several other departments under the State Council. As decision-makers have come to realize the potential of CAPSim, financial support has grown. Recently the government has committed about Ruminbi 8 million (US \$1 million) to CCAP to develop a CAPSim-based decision support system for the government. This is the largest social and economic research grant in China.

The direct effects of the IMPACT framework in the aftermath of the Brown publication were felt to be in helping to focus on the unrealistic assumptions in the book. On the contrary, IMPACT publications provided details of alternative assumptions and simulations, and these could be assessed and debated. The IMPACT work certainly influenced policy researchers in China who were involved in formulating policy options for consideration by the government. Besides CCAP, the Institute of Agricultural Economics (IAE) of the Chinese Academy of Agricultural Sciences was using the information flowing from the IMPACT publications in its policy advice also. IAE is influential primarily in the Ministry of Agriculture, whereas CCAP is influential both there and in other ministries, in the State Council, and even at the level of the Premier because it is located in the Chinese Academy of Sciences.

After sometimes intense scrutiny, at the highest levels of government, of alternative policies suggested by CCAP and IAE in the late 1990s, there is now a policy of food security rather than food self-sufficiency in the long term. This envisages grain imports of up to 5 percent of consumption. One of the most uncertain aspects of the formulation of food policy in China relates to the wide variability in projections of per capita food demand and its composition. Estimates range from 370 to 425 kilograms per capita per year. Senior economists acknowledge that Brown served to enhance awareness in China of the environmental consequences of alternative policies. This and the ability of CAPSim and IMPACT to assess alternative policy options to self-sufficiency are leading to a more liberalized competitive market with consequent reductions in grain prices. This is accompanied by reduced cultivation on marginal lands and a return to grazing on them, along with a shift of arable lands back into forest.

Another illustration of the response to the alternatives proposed by the architects of CAPSim and IMPACT is

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<sup>14</sup> CAPSim and IMPACT are compared and contrasted with other models used to examine food scenarios in China by Fan and Agcaoili-Sombilla (1997). This paper was prepared for a conference in 1996 in China to respond to Brown's book. The conference concluded that China could feed itself and this message was conveyed to the highest levels of government. Fan and Agcaoili-Sombilla pointed out that grain coverage differs in the two models. CAPSim uses lower population and income growth assumptions for China and separates urban from rural demand there. These and other differences in the models and their assumptions explain the variation in results according to Fan and Agcaoili-Sombilla. They indicate the pessimism of Brown largely arises from his low grain production projections based on unrealistic assumptions about arable land reductions from encroachment for industrial and urban uses, and modest yield gains. They are confident about continued yield gains because they expect a response by the government in the form of increased agricultural R&D investments. Also, recent evidence suggests China's arable land area has been underestimated by about 30 percent.

<sup>15</sup> It seems, though, that faculty of university agricultural economics and economics departments are more familiar with the IMPACT framework and publications. However, even there the lack of Chinese translations limits their effectiveness. The author understands the deans of economics faculties in China are discussing with IFPRI how to correct this.

the trend in China's investments in agricultural research. Both approaches recommended substantial increases in agricultural R&D spending to boost agricultural productivity growth, in lieu of a self-sufficiency strategy based on protection and subsidies.<sup>16</sup> In the period 1986–91, agricultural research expenditure in China grew by 2.8 percent per year, rising to 5.5 percent per year in 1991–96 (Pardey and Beintema 2001, derived from Fan, Qian, and Zhang forthcoming). In the period 1996–99, the real rate of growth almost doubled to 9.1 percent per year, even though real expenditure actually fell from 1996 to 1997 (private communication, Fan 2002). The substantial increases occurred in 1998 and 1999. While attribution is heroic, this dramatic increase suggests it is more than a coincidence, which is the impression one also gets from discussions in China. The high rates of return to agricultural research now well documented by Alston et al. (2000) suggest such increments in investments will have large economic benefits, some of which can be attributed to the influence of CAPSim and IMPACT.<sup>17</sup> In Appendix 4, an estimate is made of these. Using very conservative assumptions, the benefit–cost ratio of the CAPSim/IMPACT research on China is around 69, with an internal rate of return of 40 percent. On pessimistic assumptions, the corresponding figures are 3.4 and 13 percent. Both estimates use the total costs of the IMPACT program, not just the China component; so it suggests one element alone has more than justified the investment in the whole program.

While there were other influences on the more considered policy responses in China to the Brown book, arguably the most influential agricultural economist in China told the author that the papers on China using the IMPACT framework in the 1990s “...were useful in balancing the debate on the pessimistic outlook of Brown.”

Half of the respondents did not choose to answer question 13 about the strengths and weaknesses of alternative frameworks to IMPACT. Those that responded alluded to a variety of strengths and weaknesses. These are listed below:

Strengths of alternatives to IMPACT:

- data and results readily available online on the web, unlike IMPACT
- more disaggregated coverage of commodities of interest
- easy to use
- more transparent than IMPACT
- more qualitative and based on consensus
- complementary to IMPACT and lends credibility to it
- simple and less demanding of data
- less expensive than IMPACT
- technically preferred on production side
- better on China with more commodity detail, better parameters from econometric studies, and policy relevance
- more consistent information
- provides general equilibrium results.

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<sup>16</sup> Rozelle, Huang, and Rosegrant (1996) showed, using IMPACT, that the 200 million ton food deficit projected by Brown would be approached if China (unrealistically) reduced agricultural research investments by 1 percent per year. Their baseline figure was for a growth rate of 3 percent per year.

<sup>17</sup> Others might equally ascribe such outcomes to Brown's alarms, which focused the Chinese government on future food security policies and stimulated research such as that on CAPSim and IMPACT.

**Table 8. Assessment of the IMPACT framework**

Question	International centers			Donors/ international organizations			Others			Total		
	Yes	No	n.a.	Yes	No	n.a.	Yes	No	n.a.	Yes	No	n.a.
13. What are their strengths and weaknesses compared to the IMPACT framework? <sup>a</sup>	-	-	5	-	-	8	-	-	5	-	-	18
14. Have you ever requested from IFPRI particular analyses using IMPACT? If yes, what was nature of request and IFPRI response?	6	8	0	2	9	0	2	5	4	10	22	4
15. Are there other colleagues who have found the IMPACT framework useful? If yes, could you provide e-mail addresses?	6	5	3	7	2	2	3	5	3	16	12	8
	(8)			(7)			(?) <sup>b</sup>			(>15)		
16. Are there other colleagues who have been critical of the IMPACT framework? If yes, could you provide e-mail addresses?	2	9	3	2	6	3	3	5	3	7	20	9
	(1)			(2)			(>1) <sup>c</sup>			(>4)		
17. Do you have any other comments on the IMPACT framework that might help in the impact assessment?	3	11	-	4	7	-	5	6	-	12	24	-

Source: Derived by the author from the survey.

n.a. indicates no answer given.

<sup>a</sup> This question was not amenable to quantitative analysis. The responses are summarized in the accompanying text.

<sup>b</sup> Two respondents indicated there were too many to specify.

<sup>c</sup> One respondent indicated he did not have the time to name them.

#### Weaknesses of alternatives to IMPACT:

- less robust
- more expensive
- not disaggregated to regional level
- less economic in approach than IMPACT
- lacks the global coverage of IMPACT



- trade not included
- more complicated
- does not take adequate account of constraints like water,
- excessive emphasis on current situation whereas IMPACT can assess effects of changing factors
- prices not endogenous like IMPACT with a trade module
- less consistent model formulations
- factors such as urbanization and dietary changes not taken into account
- inadequate disaggregation
- difficult to use and interpret
- inflexible in changing assumptions.

Ten respondents had requested IFPRI to undertake analyses using the IMPACT framework (question 14, Table 8). Six of these were from the centers. Most of these requests were to add to the commodity coverage, change some assumptions, and/or provide more detailed results than in the published documents. In general, there was a positive and prompt response from IFPRI.

Sixteen respondents indicated they were aware of colleagues who had found the IMPACT framework useful, and they provided 15 addresses, which were subsequently used in the supplementary survey (question 15, Table 8). Twelve respondents indicated they did not know of any colleagues who had found it useful, and eight did not answer the question. In answer to question 16, seven respondents indicated they were aware of colleagues who were critical of the IMPACT framework, 20 said they were not aware of any, and nine did not answer. Only four addresses were given to enable inclusion in the supplementary survey. On the basis of these two questions, it appears that many more are favorably disposed to the IMPACT framework than critical of it. Regrettably, the response rate to the supplementary survey was so poor (16 percent) that it was not possible to explore this further.

Only one-third of respondents provided comments in answer to the last question (17). The range of comments were as follows:

- virtue of the model is the care taken in development of synthetic elasticities of demand and supply, although there are some questions about the area responses
- accessibility to the model is somewhat limited and it would be helpful if this could be addressed so that it could be downloaded from the web or available on a CD
- the demand and supply projections are extremely valuable to me and my colleagues
- a weakness of the model is the weak links between the agricultural and nonagricultural sectors
- water constraints should be included in the model
- results of the IMPACT framework are visible but the model itself is not, even though it is the analytical core
- the publications are very informative
- the framework has been proven in the market as being worthwhile

- could be more publications on the West Asia and North Africa region
- country studies should be done with the collaboration of knowledgeable experts in the countries rather than being dependent on international data sources
- evaluating the IMPACT model is rather narrow; people know IFPRI but not the IMPACT model.

## 5. CONCLUSIONS

The IMPACT framework has generated an extremely impressive array of outputs, consisting of 108 publications in the space of eight years. Of these, 55 percent have been published in externally refereed books and journals. These outputs have had discernible outcomes and influence on the international R&D community. While its externally published outputs are not among the most cited from IFPRI, the demand for key IMPACT outputs published by IFPRI exceeds that of most others. IMPACT projections are widely used and cited in strategic planning and priority setting exercises of international centers, donors, international organizations, and national programs. Its global perspectives are more sought after than those focused on specific commodities or regions. It may or may not be coincidental that a recent validation study of the various projection models in use, including IMPACT, concluded that they all did much better at accurately projecting global statistics than they did with more disaggregated statistics.

Further evidence of the influence of IMPACT is the derived demand it has generated for specific analyses and projections by a wide range of organizations and translation of some documents by others. The former requests have always been responded to positively and expeditiously by IFPRI, considerably enhancing the value of the framework. There are increasing requests by economists for the model to be made more accessible and transparent than it has been to date. There has been a reluctance to do this until recently to minimize the possibilities of inappropriate analyses being conducted and inferences drawn. It is timely that the model is now being made available on the web.

The key IMPACT publications had been read by the vast majority of respondents to a survey conducted as a part of this study to elicit perceptions of their value and impact. About two-thirds of respondents found the publications contained new information and insights. IMPACT was felt to have a comprehensive global, rigorous, and flexible analytical framework as its foundation and strength, which contrasted it with alternative projection models. Its application to emergent policy issues over the past eight years has clearly been a major ingredient in its success, as well as the continuous refinements to the model and updating of parameters and baseline data. The 2020 Vision initiative has provided an excellent vehicle to communicate the results of these analyses. Indeed, as Paarlberg (1999) noted, the IMPACT framework has been a vital component of this.

Among respondents, the IFPRI publications were much more popular than refereed journal papers. This could be interpreted to imply a possible trade-off between the professional interests of the IFPRI researchers involved and the interest of the institution in generating other components of and shorter-run impacts. However, as academics were less than 5 percent of the sample (although 16 percent of the respondents), we may not have adequately elicited the longer-run value of refereed journal papers in the survey conducted. Encouraging staff to publish in professional outlets can ensure high-quality outputs and consequent influence.

The survey revealed that IMPACT publications were generally used extensively in research and to a lesser extent in policy formulation, although frequently in strategic planning and priority assessment. They were used in advocacy and preparations of policy briefs for ministers and in university courses, from political science to development economics. The publications on the livestock revolution and China arguably have had the most discernable impact. While the IFPRI publications with a global perspective were in much heavier demand than any others, it was not possible to articulate and value the impact of this.

The livestock publications helped elevate the priority accorded to livestock among the international community, especially the way in which smallholder livestock R&D strategies are conceptualized. This is being matched by investments in new initiatives by the CGIAR and the WB, for example. The CAPSim and IMPACT publications on future scenarios for China provided timely and valued alternative policy options to food self-sufficiency, which the government had embarked on in response to concerns about China's ability to feed itself in the longer term. The options concerning market liberalization and investments in agricultural research and development were given rigorous consideration at the highest levels, and policies were modified accordingly. The likely economic benefits of these changes are high and some portion of them can be ascribed to the insights derived from CAPSim and IMPACT. A conservative estimate is that the benefit-cost ratio of CAPSim/IMPACT research on China that led to greatly increased agricultural R&D investments is 69, with an internal rate of return of 40 percent.

The IMPACT framework represents a valuable international public good, which has been and continues to be refined and expanded to address emergent food policy issues. The number of alternatives to IMPACT has declined in recent years and now numbers only three. IMPACT has unique features that are acknowledged by peers. If it is made more accessible and continues to be refined and relevant, it should remain a wise investment for IFPRI and the international community.

## 6. LESSONS LEARNED

IFPRI could benefit from a number of lessons in this impact study. Some reinforce earlier experiences from other impact studies and some are new.

- The success of the IMPACT framework has been due largely to the strong and sustained institutional commitment of human and financial resources over an extended period of years. This has ensured continuity, responsiveness, and a corporate memory. It has also allowed the development of institutional collaboration, both across divisions within IFPRI and among NARS and other CGIAR centers. This has all been conducive to sustained influence and impact.
- The integration of the IMPACT framework with IFPRI Vision 2020, arguably one of the most successful communications and marketing initiatives in policy research, has undoubtedly resulted in multiplicative effects and impacts. It is an example for others to follow. The epitome of this has been the peer recognition recently accorded to IMPACT and Vision 2020 in the form of the World Food Prize to Per Pinstrup-Andersen and the AAEEA Distinguished Policy Contribution Award to him, Rajul Pandya-Lorch, and Mark Rosegrant.
- The IMPACT publications produced by IFPRI were much more frequently read than those in refereed external publications, judging from both a citation analysis and a survey of users. Arguably then, the IFPRI publications have the most influence on policy and hence potential socioeconomic impact rather than those appearing in external publications like refereed journals and books. However, the latter are of higher priority for the professional advancement of staff, especially outside of IFPRI and in the longer run. Hence there may be a trade-off in promoting the interests of the institution versus those of the researcher. This issue deserves closer study, as publications by staff in the peer-reviewed professional literature have other international public good attributes and add to IFPRI's standing and credibility.
- There is value in making models such as IMPACT more transparent and readily available to peers, collaborators, and students, and perhaps earlier in the research cycle than was evident in this case. With the advent of the web, this is now a relatively low-cost exercise. It is acknowledged that ensuring the quality and protecting the intellectual property associated with the development of the model for a period is appropriate before it is made freely available for others to use. However, as was the case here, eight years may be considered too long for an institution mandated to produce international public goods. Earlier release may have stimulated others to further refine the model and improve the database and parameter estimates. It could have also served to enhance collaboration with its architects to apply it on new issues.
- There may be value in reviewing translation policies in IFPRI. The Japanese made their own translation of one publication of special interest to them. The Chinese expressed a strong desire to collaborate with IFPRI in translating

more of its publications in future, not only those involving IMPACT. Indeed, it appears that one reason IMPACT was influential in China was that results from a related model CAPSim were translated into papers and briefs by the Chinese economist who developed it.

- Model projections using IMPACT were much more accurate in an *ex post facto* sense when used for global aggregative scenario analyses than in regional and individual commodity projections. This raises important questions about the value and desirability of according higher priority to research on calibration and validation of country and regional models than on the global framework. The example of CAPSim in China suggests there may be high payoffs to this type of future emphasis.
- It would make the task of external evaluators of the impact of IFPRI's research easier if the staff involved could record and assemble information on outcomes and influences such as that described in the section on tangible indicators. This would include citation analyses, requests for publications, and various types of derived demands for the outputs from the research programs. The external evaluators could then devote more time to validating these and following up with users to endeavor to translate them into policy influences and measures of the ultimate impact on socioeconomic welfare and the environment. In this respect, IFPRI should consider, in collaboration with other centers, investing in sizeable subscription charges to allow regular use of the SCI/SCCI and Web of Science databases. This could have value both in the institutionalization of impact assessment and in staff evaluations.

**Appendix 1. Publications and Papers that Utilize the IMPACT Global Food Supply and Demand Model (in reverse chronological order within classifications)**

**I. Books, monographs, and book chapters**

- Cai, X., and M. W. Rosegrant. Forthcoming. Water availability and the future of irrigated and rainfed cereal production. In *Land quality, agricultural productivity, and food security*, ed. K. D. Wiebe. Elgar Publishing.
- Evenson, R. E., and M. W. Rosegrant. Forthcoming. The economic consequences of crop genetic improvement programs. In *Crop variety improvement and its effect on productivity: The impact of international agricultural research*, eds. R. E. Evenson and M. W. Rosegrant. Wallingford, UK: CAB International.
- Cohen, M. J. 2002. Food security: Why do hunger and malnutrition persist in a world of plenty? In *Plants, genes, and crop biotechnology*, 2nd ed., eds. M. J. Chrispeels and D. E. Sadava. Sudbury, Mass.: Jones and Bartlett.
- Pandya-Lorch, R., K. M. Leisinger, and K. M. Schmitt. 2002. *Six billion and counting: Population and food security in the 21<sup>st</sup> century*. Baltimore, Md.: Johns Hopkins University Press.
- Pinstrup-Andersen, P., and M. J. Cohen. 2001a. Modern agricultural biotechnology and developing country food security. In *Genetically modified organisms in agriculture—Economics and politics*, ed. G. C. Nelson. Academic Press.
- Pinstrup-Andersen, P., and M. J. Cohen. 2001b. Rich and poor country perspectives on biotechnology. In *The future of food*, ed. P. G. Pardey. Washington, D.C.: IFPRI.
- Pinstrup-Andersen, P., and R. Pandya-Lorch. 2001a. Meeting food needs in the 21<sup>st</sup> century: How many and who will be fed? In *Who will be fed in the 21<sup>st</sup> century? Challenges for science and policy*, eds. K. Wiebe, N. Ballenger, and P. Pinstrup-Andersen. Baltimore, Md.: Johns Hopkins University Press.
- Pinstrup-Andersen, P., and R. Pandya-Lorch. 2001b. *The unfinished agenda: Perspectives on overcoming hunger, poverty, and environmental degradation*. Washington, D.C.: IFPRI.
- Rosegrant M. W., M. S. Paisner, S. Meijer, and J. Witcover. 2001a. *Global food projections to 2020: Emerging trends and alternative futures*. 2020 Vision. Washington, D.C.: IFPRI.
- Rosegrant M. W., M. S. Paisner, S. Meijer, and J. Witcover. 2001b. *2020 global food outlook: Trends, alternatives, and choices*. A 2020 Vision Food Policy Report. Washington, D.C.: IFPRI.

- Cohen, M. J. 2000a. *Food aid and food security trends: Worldwide needs, flows, and channels*. The Hague: European Association of Non-Governmental Organisations for Food Aid and Emergency Aid [EuronAid].
- Cohen, M. J. 2000b. Modern biotechnology for food and agriculture: Risks and opportunities for the poor. In *Agricultural biotechnology and the poor*, eds. G. J. Persley and M. M. Lantin. Washington, D.C.: CGIAR.
- Pandya-Lorch, R. 2000a. Food prospects and potential imports of low-income countries in the twenty-first century. In *Food aid and human security*, eds. E. Clay and O. Stokke. Portland, Ore.: Frank Cass.
- Pandya-Lorch, R. 2000b. Prospects for global food security: A Central Asian context. In *Food policy reforms in Central Asia: Setting the research priorities*, eds. S. Babu and A. Tashmatov. Washington, D.C.: IFPRI.
- Pinstrup-Andersen, P., and M. J. Cohen. 2000. Modern biotechnology for food and agriculture: Risks and opportunities for the poor. In *Agricultural biotechnology and the poor*, eds. G. J. Persley and M. M. Lantin. Washington, D.C.: CGIAR.
- Pinstrup-Andersen, P., and M. J. Cohen. 2000. The present situation and coming trends in world food production and consumption. In *Food needs of the developing world in the early twenty-first century*, eds. T. T. Chang, B. M. Colombo, and M. Sánchez-Sorondo. Vatican City: Pontifical Academy of Sciences.
- Pinstrup-Andersen, P., and R. Pandya-Lorch. 2000. Aussichten für die globale Ernährungssicherung im 21. Jahrhundert. In *Jahrbuch Welternährung: Daten trends perspektiven*. Frankfurt am Main: Fischer, Taschenbuch, Verlag GmbH.
- Rosegrant, M. W., and P. B. R. Hazell. 2000. *Transforming the rural Asian economy: The unfinished revolution*, Chapter XII. Hong Kong: Oxford University Press.
- Pandya-Lorch, R. 1999. Prospects for global food security. In *Proceedings of the study-week of the Pontifical Academy of Sciences, March 12–16*, eds. V. I. Keilis-Borok and M. Sanchez Sorondo. Vatican City: Pontifical Academy of Science.
- Pinstrup-Andersen, P., and R. Pandya-Lorch. 1999. Securing and sustaining adequate world food production for the third millennium. In *World food security and sustainability: The impacts of biotechnology and industrial consolidation*, eds. D. P. Weeks, J. B. Segelken, and R. W. F. Hardy. National Agricultural Biotechnology Council.



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- Pinstrup-Andersen, P., and R. Pandya-Lorch. 1999. Food security: A global perspective. In *Food security, diversification and resource management: Refocusing the role of agriculture?* Proceedings of the Twenty-third International Conference of Agricultural Economists, eds. G. H. Peters and J. von Braun. Aldershot, UK: Ashgate Publishing.
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- Pinstrup-Andersen, P., and R. Pandya-Lorch. 1998. Major uncertainties and risks affecting long-term food supply and demand. In *The future of food: Long-term prospects for the agro-food sector*. Paris: Organisation for Economic Co-operation and Development.
- Pinstrup-Andersen, P., and R. Pandya-Lorch. 1997. Management challenges in the developing world. In *Proceedings of the 11<sup>th</sup> International Farm Management Congress*, July 15, ed. L. Bauer. Calgary, Alberta, Canada: International Farm Management Association.
- Cohen, M. J., and J. D'Costa. 1996. Overview of world hunger. In *What governments can do: Hunger 1997*, ed. J. Cohen. Silver Spring, Md.: Bread for the World Institute.
- Pinstrup-Andersen, P., and R. Pandya-Lorch. 1996. Designing long-term scenarios: Prospects for global agriculture. In *Globalisation and linkages to 2020: Challenges and opportunities for OECD countries*, OECD Proceedings of the High-Level Experts Meeting, Paris, France, 17–18 June.
- Pinstrup-Andersen, P., and R. Pandya-Lorch. 1996. Population growth and future food security. In *Land, food, and people: Challenges for future food supply, agricultural development, and the environment*. Proceedings of the 150<sup>th</sup> Anniversary Seminar at the Royal Agricultural College, Cirencester, Gloucestershire, England, 29 September, ed. W. P. Davis. Great Britain: Eye Press Ltd.
- Pinstrup-Andersen, P., and R. Pandya-Lorch. 1995. Prospects for world food security and distribution. In *Eco-regional approaches for sustainable land use and food production*, eds. J. Bouma, A. Kuyvenhoven, B. A. M. Bouman,

J. C. Luyten, and H. G. Zandstra. Netherlands: Kluwer Academic Publishers and the International Potato Center.

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- Rosegrant, M. W., and S. Meijer. 2002. Past accomplishments and alternative futures for child malnutrition to 2020. *Journal of Nutrition*. Forthcoming.
- Delgado, C. L., M. W. Rosegrant, H. Steinfeld, S. Ehui, and C. Courbois. 2001. Livestock to 2020: The next food revolution. *Outlook on Agriculture* 30 (1, March): 27–29.
- Rosegrant, M. W., and X. Cai. 2001. Water scarcity and food security: alternative futures for the 21st century. *Journal of Water Science and Technology* 43 (4): 61–70.
- Pandya-Lorch, R., and M. W. Rosegrant. 2000. Prospects for food demand and supply in Central Asia. *Food Policy* 25 (6): 637–646.
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- Pinstrup-Andersen, P., and M. J. Cohen. 2000. Closing the food gap. *Farm Chemicals International* (March): 25.
- Pinstrup-Andersen, P., R. Pandya-Lorch, and M. W. Rosegrant. 2000. World food prospects. *Agrarwirtschaft* 49 (9/10), Special issue on Meeting the Food Challenge of the Twenty-First Century.
- Rosegrant, M. W., and C. Ringler. 2000. Asian economic crisis and the long-term global food situation. *Food Policy* 25 (3): 243–254. Special issue on Policy Reform, Market Stability, and Food Security.
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- Scott, G. J., M. W. Rosegrant, and C. Ringler. 2000. Global projections for root and tuber crops to the year 2020. *Food Policy* 25 (5): 561–597.
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- Huang, J., S. Rozelle, and M. W. Rosegrant. 1999. China's food economy to the 21<sup>st</sup> century. *Economic Development and Cultural Change* 47 (4): 737–766.

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- Rosegrant, M. W., N. Leach, and R. V. Gerpacio. 1999. Alternative futures for world cereal and meat consumption. *Proceedings of the Nutrition Society* 58 (2): 219–234.
- Pingali, P., and M. W. Rosegrant. 1998. Supplying wheat for Asia's increasingly Westernized diets. *American Journal of Agricultural Economics* 80 (5): 954–959.
- Pinstrup-Andersen, P., and R. Pandya-Lorch. 1998. Assuring a food secure world in the 21<sup>st</sup> century: Challenges and opportunities. *Canadian Journal of Development Studies* 19: 37–54.
- San, N. N., M. W. Rosegrant, and N. D. Perez. 1998. Indonesian agriculture in transition: Projections of alternative futures. *Journal of Asian Economics* 9 (3): 445–465.
- Kumar, P., and M. W. Rosegrant. 1997. Dynamic supply response of cereals and supply projections: A 2020 vision. *Agricultural Economic Research Review* 10 (1): 3–22.
- Pinstrup-Andersen, P., and R. Pandya-Lorch. 1997. World food needs toward 2020. *American Journal of Agricultural Economics* 79 (5): 1465–1466.
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- Rosegrant, M. W., and M. A. Sombilla. 1997. Critical issues suggested by trends in food, population, and the environment to the year 2020. *American Journal of Agricultural Economics* 79 (5): 1467–1470.
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- Agcaoili-Sombilla, M. C., and M. W. Rosegrant. 1996. South Asia and the global food situation: Challenges for strengthening food security. *Journal of Asian Economics* 7 (2): 265–292.

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Scott, G. J., M. W. Rosegrant, and C. Ringler. 2000. *Roots and tubers for the 21st century: Trends, projections, and policy options*. 2020 Vision for Food, Agriculture, and Environment Discussion Paper No. 31. Washington, D.C.: IFPRI.

Delgado, C. L., M. W. Rosegrant, H. Steinfeld, S. Ehui, and C. Courbois. 1999. *Livestock to 2020: The next food revolution*. 2020 Vision for Food, Agriculture, and the Environment Discussion Paper No. 28. Washington, D.C.: IFPRI (co-published with ILRI and FAO).

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Rosegrant, M. W., J. Huang, and S. Rozelle. 1997. *China's food economy to the 21st century: Supply, demand, and trade*. 2020 Vision Food, Agriculture and Environment Discussion Paper No. 19. IFPRI, Washington, D.C.

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- Delgado, C. L., M. W. Rosegrant, and S. Meijer. 2001. Livestock to 2020: The revolution continues. Paper presented at the annual meetings of the International Agricultural Trade Research Consortium (IATRC), Auckland, New Zealand, 18–19 January.
- Pinstrup-Andersen, P., and R. Pandya-Lorch. 2001. Overview of the world food situation. Paper prepared for the CGIAR Annual General Meeting, Washington, D.C., 30 October.
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- Rosegrant, M. W., M. S. Paisner, and S. Meijer. 2001. Subsistence to supermarket? Future trends in Asian food demand and supply. Paper prepared for the Australian Department of Foreign Affairs and Trade.
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- Rosegrant, M. W., and X. Cai. 2000. Water scarcity and food security: Alternative futures for the 21<sup>st</sup> century. Paper presented at the 10th Stockholm Water Symposium, 14–17 August.
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## Appendix 2. Questionnaire and Accompanying Letter Used in Survey

International Food Policy Research  
Institute  
2033 K Street, N.W.  
Washington, D.C. 20006  
U.S.A.

December 15, 2001

Dear colleague,

I am conducting an evaluation of the impact of the work that IFPRI has done on developing and using the IMPACT framework (International Model for Policy Analysis of Agricultural Commodities and Trade). This is part of IFPRI's ongoing impact evaluation program, which aims to document and measure the influence of IFPRI's research and related activities so that its quality and relevance can be assessed.

The IMPACT framework has been used extensively to address key food policy issues over the past several years. These include the influence on world food markets and food and nutrition security of China and South Asia, the effects of environmental degradation, water constraints on agriculture, the Asian economic crisis, future livestock demand scenarios and of roots and tubers, among other topics. I would greatly appreciate it if you could spare a few minutes to respond to some questions about this work and your impressions of it. I attach a short questionnaire for this purpose.

I would be grateful if you could return the questionnaire to Ms. Adwoa Boateng at IFPRI by either e-mail ([A.Boateng@cgiar.org](mailto:A.Boateng@cgiar.org)) fax (+1 202 467 4439) or by mail (IFPRI 2033 K St. N.W. Washington D.C. 20006-1002 U.S.A.). If it were possible to do this by January 25, 2002 it would be most helpful.

Thanking you in anticipation for your assistance.

Yours sincerely,

Jim Ryan

Visiting Fellow, Economics Division of  
the Research School of Pacific and Asian  
Studies, Australian National University,  
Canberra A.C.T.  
Consultant to IFPRI on Impact  
Evaluation

### **Some Significant Publications Using the IMPACT Framework (in chronological order)**

1. Rozelle, S., J. Huang, and M. W. Rosegrant. 1996. Why China will not starve the world. *Choices* (First Quarter): 18–25.
2. Fan, S., and M. Agcaoili-Sombilla. 1997. Why projections on China's future food supply and demand differ. *The Australian Journal of Agricultural Economics* 41 (2): 169–190.
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13. Scott, G. J., M. W. Rosegrant, and C. Ringler. 2000. Global projections for root and tuber crops to the year 2020. *Food Policy* 25 (5): 561–597.
14. Rosegrant, M. W., M. S. Paisner, S. Meijer, and J. Witcover. 2001. *2020 global food outlook: Trends, alternatives, and choices*. 2020 Vision Food Policy Report. Washington, D.C.: IFPRI.
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## **Confidential**

### **Questionnaire on Use and Influence of IMPACT Framework (International Model for Policy Analysis of Agricultural Commodities and Trade)**

1. Name:
2. Position and responsibilities:
3. Organization and address:
4. Telephone:  
Fax:  
E-mail:
5. Date:
6. Have you read or consulted any of the publications where the IMPACT framework has been used?
7. If yes, can you indicate which ones? (A list of the significant publications is attached to assist you; please use the numbers assigned to each.)  
[ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]  
Others not on the list? (Please provide reference details.)
8. Was there any new and/or surprising information in any of the above publications?  
yes [ ] no [ ]  
If yes, could you list some examples?
9. Have you used information from IMPACT publications?  
(a) in a policy context?  
yes [ ] no [ ]

If yes, could you indicate in what context?

(b) in your research?

yes [ ] no [ ]

If yes, could you list your publications where you cited IMPACT publications?

( c ) in your teaching?

yes [ ] no [ ]

If yes, in what courses at what institutions and in what years?

10. Has IMPACT modeling information been influential in formulating policies or strategies in your institution?

yes [ ] no [ ]

If yes, could you describe how?

11. What other sources besides the IMPACT publications have you used for projections?

12. How influential have they been?  
very influential [ ] somewhat influential [ ] no influence [ ]
13. What are their strengths and weaknesses compared to the IMPACT framework?  
(a) Strengths:
- (b) Weaknesses:
14. Have you ever requested from IFPRI that particular analyses using the IMPACT framework be undertaken?  
yes [ ] no [ ]
- If yes, what was the nature of the request and the response from IFPRI?
15. Are there other colleagues who you are aware of that have found the IMPACT framework useful?  
yes [ ] no [ ]
- If yes, could you provide their e-mail addresses so they can be contacted?
16. Are there other colleagues who have been critical of the IMPACT framework?  
yes [ ] no [ ]
- If yes, could you provide their e-mail addresses so they can be contacted?
17. Do you have any other comments regarding the IMPACT framework that might help in the impact assessment?

**Thank you very much for taking the time to complete this questionnaire.**

**PLEASE RETURN THE QUESTIONNAIRE BY JANUARY 25, 2002 TO MS. ADWOA BOATENG AT IFPRI BY E-MAIL ATTACHMENT ([A.BEATENG@CGIAR.ORG](mailto:A.BEATENG@CGIAR.ORG)) FAX (+1 202 467 4439) OR BY MAIL (IFPRI 2033 K ST. NW, WASHINGTON D.C. 2006-1002, U.S.A.)**

### **Appendix 3. Persons Contacted During Evaluation and Respondents to Survey**

#### **Academic Institutions—Developed Countries**

Ronald Duncan, Executive Director, National Centre for Development Studies,  
Australian National University, Canberra  
Frans Neuman, International Agricultural Centre, Wageningen  
Alex McCalla, Professor Emeritus, University of California, Davis  
Rob Paarlberg, Professor of Political Science, Wellesley College

#### **Academic Institutions—Developing Countries**

Chu Baojin, Professor, College of Economics and Trade, Nanjing Agricultural  
University  
Zhong Tang, Chairman, Department of Agricultural Economics, Renmin University  
of China  
Sukhadeo Thorat, Professor of Economics, Jawaharlal Nehru University, New Delhi  
Simei Wen, Director, Institute of Economic Development, South China Agricultural  
University  
Zhang Yong, Associate Professor, Department of Extension Management, Sichuan  
Academy of Agricultural Sciences  
Funing Zhong, Professor and Dean, College of Economics and Trade, Nanjing  
Agricultural University

#### **Consultants/ Private Sector**

Claudio Barriga, Executive Secretary AARINA, ANEGLA Chile Ltd.  
Christo Hilan, Director of Fanar Laboratory, Lebanon  
Usha Barwale Zehr, Joint Director, Research, MAHYCO India

#### **Donors/International Agencies**

Sarah Cook, Program Officer, Ford Foundation  
Dana Dalrymple, Research Adviser, Office of Agriculture and Food Security, Center  
for Economic Growth and Agricultural Development, USAID  
Cornelis de Haan, Senior Adviser, Livestock Development, The WB  
Manual Lantin, Science Adviser, CGIAR Secretariat, The WB  
Roberto Lenton, Executive Director, International Research Institute for Climate  
Prediction  
Iain MacGillivray, Senior Adviser, CIDA  
Peter Matlon, Deputy Director for Food Security, Rockefeller Foundation  
Don Mentz, Executive Director, The Crawford Fund  
Abbas Monofali, International Relations Division, Arab Authority for Agricultural  
Investment and Development



Eva Ohlsson, Senior Research Officer, SIDA/SAREC  
Vialatte Philippe, Principal Administrator, Environment and Rural Development Unit,  
European Commission  
David S. Sobel, Senior Country Officer for China, Asian Development Bank  
Deborah Jane Templeton, Senior Economist, Impact Assessment Program, ACIAR  
Robert Thompson, Director, Rural Development Department, The WB  
Klaus Winkel, Head of Department for Development Research, DANIDA  
Elke Wolff, Section for World Food Security and Rural Development, Ministry for  
Cooperation and Development (BMZ)

### **International Centers**

Mahfuzuddin Ahmed, Senior Scientist, ICLARM  
Upali Amarasinghe, Senior Regional Researcher, IWMI  
Aden A. Aw-Hassan, Senior Scientist, ICARDA  
Denis Blight, CAB International  
Shenggen Fan, Senior Research Fellow, IFPRI  
Hank Fitzhugh, Director General, ILRI  
A. A. de Freeman, Head Impact Assessment Office, ICRISAT  
Willem Janssen, Program Director, ISNAR  
Frederic Lancon, Policy Economist, WARDA  
Victor M. Manyong, Project Coordinator, IITA  
Michael Morris, Associate Director, Economics Program, CIMMYT  
Rajul Pandya-Lorch, Coordinator, 2020 Vision IFPRI  
Per Pinstrup-Andersen, Director General, IFPRI  
Mark Rosegrant, Senior Research Fellow, IFPRI  
Amit H. Roy, President, International Fertilizer Development Center  
Farouk Shomo, Economic Research Associate, ICARDA  
Mike Spilisbury, Research Programme Analyst, CIFOR  
John Vercoe, Chair Board of Trustees, ILRI  
Jamie Watts, Scientist, Impact Assessment and Evaluation, IPGRI

### **National Agricultural Research and Development Systems**

Chu Thi Hao, Deputy Director, Department of Agricultural Policy and Rural  
Development, Ministry of Agriculture and Rural Development, Vietnam  
Jikun Huang, Director, Center for Chinese Agricultural Policy, Chinese Academy of  
Sciences  
Bing-Kun Li, Director General, Bureau of Rural Economic Research, Policy Office of  
the State Council, China  
Justin Yifu Lin, Director, China Center for Economics Research  
Chengfang Liu, Senior Research Assistant, CCAP  
Keming Qian, Director General, Institute of Agricultural Economics, Chinese  
Academy of Agricultural Sciences  
Mahmoud Roozitalab, Deputy Head, Agricultural Research, Education and Extension  
Organization, Iran  
Panjab Singh, Secretary to the Government of India and Director General, ICAR

Linxiu Zhang, Deputy Director, Center for Chinese Agricultural Policy, Chinese Academy of Sciences

**Nongovernmental Organizations**

Ann Waters-Bayer, Chair CGIAR NGO Committee and Senior Advisor ETC  
EcoCulture

#### **Appendix 4. Benefit–Cost Analysis of Incremental Agricultural Research Investments in China**

Appendix Table 4.1 contains data on the changes in investments in agricultural research in China from 1996 to 2010 under two scenarios. The first uses actual data from 1996 to 1999 and then projects to 2010 using the actual growth rate from 1996 to 1999 of 9.1 percent per year (column 2). The second uses the growth rate from 1992 to 1996 as reported in Pardey and Beintema (2001) of 5.5 percent per year to project to 2010 (column 3). The difference between the two investment streams shown in the fourth column (column 3 – column 2) represents the incremental investment that has occurred due to the rapid increase in the growth of research investments since 1996. Assuming the average return to research in Asia as reported by Alston et al. (2000) of 78.1 percent per year applies to this incremental investment will lead to the estimated annual incremental economic benefits due to the enhanced rate of growth shown in the fifth column of the table.

One way to ascribe a portion of the total incremental benefits in the fifth column to the policy research information flowing from the research involving the CAPSim and IMPACT frameworks in China is to assume it caused the increased research investments to occur earlier than they otherwise would have. In column 6, we show the flow of benefits from a one-year delay in the absence of the research information. This is a quite conservative assumption, with a lack of firm information otherwise. It is, however, consistent with the time saving Ryan (2002a) found in his evaluation of rice policy research in Vietnam. Column 7 shows the difference between columns 5 and 6, which is the estimate of the benefits from the research based on the one-year time saving assumption.

An even more conservative though more arbitrary assumption is that the research can claim 1 percent of the estimated total incremental benefits. This is what Dollar (2001) assumed about the effects of research on improving the efficiency of aid. The size of the benefits based on the 1 percent assumption is shown in the last column.

The estimated total accumulated cost of the IMPACT program by IFPRI is \$2.6 million as of 1999.<sup>18</sup> This is, if anything, an overestimate. We use this figure as the cost component and two estimates of the benefits from columns 7 and 8 of the table in a benefit/cost analysis. At a discount rate of 5 percent and assuming that, unlike what is shown in the table, there is an 11-year gestation lag before the incremental investments in research led to the economic benefits shown (i.e., they begin in 2010, not 1999, and last only ten years), the following results:

---

<sup>18</sup> This includes the original cost of the collaboration with J. Huang that led to the CAPSim framework. It also includes all the other research that has been done on the IMPACT framework, as described in this paper. Hence it vastly overestimates the China component.

<b>Estimate</b>	<b>Benefit-cost Ratio</b>	<b>Internal rate of return (%)</b>
Very conservative	69.0	40
Pessimistic	3.4	13

**Appendix Table 4.1. Projected agricultural research investments and benefits in China under two scenarios (US \$millions)**

Year (1)	Projected research investment growth @9.1% from 2000 (2)	Projected research investment growth @ 5.5% from 1996 (3)	Increment in research investment (4)	Incremental economic benefits from incremental research investment (5)	Delayed incremental economic benefits (6)	Incremental economic benefit from no delay (7)	1% of incremental economic benefits (8)
1999	628	577	51	40	0	40	0.40
2000	685	609	76	59	40	19	0.59
2001	747	642	105	82	59	23	0.82
2002	815	677	138	108	82	26	1.08
2003	890	715	175	137	108	29	1.37
2004	971	754	217	170	137	33	1.70
2005	1,059	796	263	205	170	35	2.05
2006	1,155	839	316	247	205	42	2.47
2007	1,261	886	375	293	247	46	2.93
2008	1,375	934	441	344	293	51	3.44
2009	1,501	986	515	402	344	58	4.02
2010	1,637	1,040	597	466	402	64	4.66

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Jim Ryan, Visiting Fellow, Economics Division of the Research School of Pacific and Asian Studies, Australian National University, Canberra, is a consultant to IFPRI on impact evaluation.

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